MATHEMATICS LEARNING AMONG MIZO TRIBE: AN ETHNOMATHEMATICAL STUDY

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TBC LALRAMNGHAKA
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MATHEMATICS LEARNING AMONG MIZO TRIBE: AN ETHNOMATHEMATICAL STUDY

By

TBC Lalramnghaka

Department of Education

Supervisor : Prof. Lokanath Mishra

Co-Supervisor : Dr. Prateek Chaurasia

Submitted

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MIZORAM UNIVERSITY

TANHRIL: MIZORAM-796004

Prof. Lokanath Mishra
Dean, School of Education ***Email: mishra.lokanath70@gmail.com***
Department of Education ***Mobile: +919457115093***

CERTIFICATE

This is to certify that **TBC Lalramnghaka, Ph.D. Scholar, Department of Education, Mizoram University,** Registration. No. MZU/Ph.D./2113 of 06.09.2022 has written his thesis entitled, **'Mathematics Learning among Mizo Tribe: An Ethnomathematical Study'** under our guidance and supervision. In preparing the thesis, TBC Lalramnghaka has complied with all the requirements as laid down in the Ph.D. Regulation of the University. The thesis is the original work of the scholar and has not been submitted for any degree to other University.

(Prof. LOKANATH MISHRA)
Supervisor

(Dr. PRATEEK CHAURASIA)
Co-supervisor

DECLARATION

MIZORAM UNIVERSITY

NOVEMBER, 2025

I **TBC Lalramnghaka,** hereby declare that the subject matter of this thesis is the record of work done by me, that the contents of this thesis did not form basis of the award of any previous degree to me or to do the best of my knowledge to anybody else, and that the thesis has not been submitted by me for any research degree in any other University/Institute.

This is being submitted to the Mizoram University for the degree of **Doctor of Philosophy in Education.**

(TBC LALRAMNGHAKA)
Candidate

(Prof. LALBIAKDIKI HNAMTE)
Head
Department of Education

(Prof. LOKANATH MISHRA)
Supervisor
Department of Education

(Dr. PRATEEK CHAURASIA)
Co-supervisor
Faculty of Education
Banaras Hindu University

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Dated: Aizawl

(TBC LALRAMNGHAKA)
Department of Education
Mizoram University

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Chapter-I

Introduction

1.1 Background

Mathematics is the universal language of logic, patterns, and relationships that helps us understand the world around us. At its core, mathematics is founded on fundamental truths that remain constant across time and cultures. Mathematics is a discipline of absolute certainty within its formal systems because it is based on axioms, definitions, and deductive reasoning, in contrast to empirical sciences that depend on observation and experimentation (Hersh, 1997). Since its conclusions are based on rigorous proof rather than physical reality, mathematical propositions are guaranteed to be eternally valid once they have been validated (Hardy, 1940). This feature sets mathematics apart from other disciplines because, unlike scientific theories, its conclusions are not subject to change. The basic ideas behind maths were structure, order, and logic. It followed rules and used symbols to make ideas clear and correct. Mathematicians used logic to look into ideas and find the truth. Definitions, theorems, and proofs made up the subject. These parts helped to explain why something was true, not just what the answer was (Bishop, 1988). It helped people think deeply and see how different things were connected. Mathematicians often got their ideas from patterns they saw in nature or in how people acted (Zaslavsky, 1999).

Numerous individuals have characterised mathematics as both a language and a science. Due to its scientific nature, it employed a systematic approach to reasoning. It incrementally enhanced understanding and substantiated notions with evidence. It elucidated topics with diagrams, symbols, and numerals. It may elucidate relationships, development, transformation, and movement. This rendered it advantageous across several disciplines, including biology, physics, and economics (Steen, 1990; Ernest, 1991). Logic, order, and structure are the fundamental essence of mathematics. It complied with laws and effectively communicated concepts using symbols. Mathematicians utilised logic to explore the concepts and ascertain facts.

Definitions, theorems, and proofs were the foundation of the subject. Instead of just delivering the answer, these parts facilitated an explanation of the rationale or its veracity (Bishop, 1988). It enabled profound contemplation and the identification of relationships among diverse entities. Natural phenomena or human conduct often served as the foundation for mathematical conceptions (Zaslavsky, 1999).

The elegance of mathematics resides in its ideal equilibrium between liberty and precision. Bertrand Russell (1919) said, "Mathematics embodies not only truth but also supreme beauty." Within the stringent confines of mathematical logic, there exists remarkable creative latitude to investigate novel concepts and uncover unforeseen relationships. The essence of mathematics was likewise universal. Various civilisations have developed their own mathematical systems. The Babylonians established early algebra, the Egyptians employed geometry in construction, and the Indians formulated the idea of zero. The Chinese and Mayans have profound mathematical traditions. Subsequently, these concepts were disseminated and enhanced by others, demonstrating that mathematics is a collective human endeavour (Joseph, 2011; Gerdes, 1996).

Mathematics was utilised not just in science but also in art, music, and design. Patterns, symmetry, and proportions prevalent in nature were employed by painters and architects to achieve beauty and harmony. Ancient edifices such as the pyramids and temples exemplified the use of mathematics. In music, rhythm and harmony adhere to mathematical principles (Livio, 2009). This demonstrated that mathematics has both practical and cultural significance. Mathematics at educational institutions facilitated the development of students' cognitive abilities and comprehension. It was essential to assist learners in recognising the connections between mathematics, life, and culture (D'Ambrosio, 2001). The objective was not just to instruct on formulae but also to facilitate students' comprehension of their underlying significance.

Mathematics in India has consistently occupied a significant position, both historically and in contemporary schooling. Ancient Indian intellectuals such as Aryabhata and Brahmagupta produced significant advancements in algebra, arithmetic, and astronomy as early as the 5th century (NCERT, 2005). In modern India,

mathematics is a fundamental topic in the educational curriculum, influenced by national education policies and committees. The National Curriculum Framework (NCF) 2005 underscored the transition from rote memorisation to conceptual comprehension, promoting the teaching of mathematics as a means of logical reasoning rather than simple recall (NCF, 2005). The Yash Pal Committee Report (1993) emphasised that mathematics instruction frequently prioritised rote problem-solving, instilling anxiety and aversion in children (Yash Pal Committee, 1993). The disjunction between policy and practice constituted a continual issue in Indian education.

The Indian National Education Policy 2020 acknowledges mathematics as an essential discipline that fosters logical reasoning and problem-solving skills (Ministry of Education, 2020). This supports the perspective that mathematics encompasses not just numbers and computations but also structured thinking and analytical abilities. The National Curriculum Framework 2005 underscores that mathematics should be taught as a mode of thinking rather than merely as a compilation of formulae (NCERT, 2005).

Modern research on schooling demonstrates that students naturally learn how to think mathematically by interacting with the world around them (National Research Council, 2009). The National Education Policy 2020 builds on this by saying that students should learn maths via activities and experiences (Ministry of Education, 2020). This method understands that arithmetic skills aren't something you are born with, but something you can learn via the right kinds of stimulus and practice.

Ultimately, mathematics was simultaneously straightforward and profound. It begins with fundamental notions such as enumeration and progresses into the most intricate domains of human cognition. It was sufficiently pragmatic to construct bridges and sufficiently abstract to investigate hypothetical realms. Bertrand Russell characterised mathematics as a discipline in which we are perpetually uncertain about the subject matter and the veracity of our statements (Russell, 1901). The prospects of mathematics education in India hinge on reconciling tradition with innovation. Simultaneously, digital technologies and AI offered novel prospects for

personalised learning, as outlined in the NEP 2020. The objective was to position mathematics not as an obstacle but as an avenue to intellectual curiosity and innovation.

1.1.1 Mathematics at the School Level

Mathematics is an essential discipline in educational curricula, significantly contributing to the cultivation of logical reasoning, problem-solving abilities, and analytical thinking. Mathematics, encompassing elementary arithmetic as well as sophisticated algebra and geometry, supports several scientific, technical, and engineering fields.

A fundamental aim of classroom mathematics is to develop an effective awareness of number. Early education emphasizes counting, addition, subtraction, multiplication, and division, which are fundamental for everyday computations (Boaler, 2016). As students' progress, they confront fractions, decimals, and percentages, which are essential for financial literacy and data analysis. A solid understanding of these fundamentals guarantees that pupils can manage more abstract notions thereafter. Algebra introduces variables and equations, enabling students to mathematically simulate real-life scenarios. The shift from concrete arithmetic to abstract reasoning is essential for cultivating advanced cognitive abilities (Van de Walle et al., 2013).

The initial phase of mathematics education emphasises fostering the development of numerical comprehension and fundamental arithmetic operations. Studies demonstrate that early mathematics proficiency is a more significant predictor of subsequent academic success than early reading abilities or socio-emotional competencies (Duncan et al., 2007). The National Curriculum Framework (NCF) 2005 emphasises the significance of tangible, activity-oriented learning at this level, advocating for the use of manipulatives and real-world situations to enhance conceptual comprehension (NCERT, 2005). This method aligns with Vygotsky's (1978) social constructivist theory, emphasising the significance of experiential learning and social interaction in cognitive development. The Kothari Commission

(1964-66) similarly pushed for transcending rote memorisation and developing authentic mathematical reasoning (Education Commission, 1966), a notion that continues to have relevance in modern educational methods. The middle school mathematics curriculum incorporates algebra and Euclidean geometry. The NEP 2020 underscores the significance of mathematical reasoning across several fields, acknowledging its contribution to the cultivation of scientific and technical literacy (Ministry of Education, 2020). Boaler's (2016) international study indicates that students learn mathematics most efficiently when they comprehend its real-world applications and participate in open-ended problem-solving activities. The Yash Pal Committee Report (1993) warned against prioritising procedural fluency above conceptual comprehension, advocating for more exploratory methodologies in mathematics instruction (NCERT,1993).

Secondary school mathematics encompasses more complex ideas such as advanced algebra, coordinate geometry, trigonometry, and basic calculus. The NCF 2005 highlights the necessity of linking advanced subjects to students' living experiences to sustain engagement and relevance (NCERT, 2005). Harel's (2008) DNR (Duality, Necessity, Repeated Reasoning) paradigm posits that students get a more profound comprehension of mathematics by active engagement in proving and problem-solving, rather than through passive knowledge absorption. The NCERT's Position Paper on the Teaching of Mathematics (2006) similarly promotes a classroom environment that prioritises reasoning, diverse solution methods, and mathematical dialogue. Studies demonstrate that these methods not only augment mathematical proficiency but also improve students' self-efficacy and excitement for the discipline (Hattie,2009).

School mathematics is crucial for cognitive development and effective problem-solving in the real world. A well-structured curriculum and competent instruction can foster a strong enthusiasm for the topic and prepare students for academic and professional challenges. Teachers may motivate pupils to do math confidently and creatively by emphasising conceptual knowledge over memorisation and applying mathematical ideas to daily life. Classroom mathematics builds cognitive

capabilities and prepares pupils for academic and professional problems. Due to programs like NEP 2020 and frameworks like NCF 2005, Indian education is becoming increasingly conceptual and application-based. Effective mathematics education involves well-trained instructors, adequate evaluation, and balanced emphasis on procedural fluency, conceptual knowledge, and problem-solving.

1.1.2 Challenges of Mathematics Learning at the Elementary Level

Mathematics is a basic subject that is important for developing logical thinking and problem-solving skills, but teaching it in primary school can be extremely difficult. One of the main problems is that mathematical ideas are sometimes too abstract for young learners to understand (National Research Council, 2001). Fractions, place value, and basic math operations are examples of foundational concepts that early-grade learners may not yet have completely developed cognitive skills for (Siegler & Lortie-Forgues, 2015). Math anxiety makes learning much harder since students who are afraid of failing stop paying attention to the subject (Ashcraft, 2002; Ramirez et al., 2018).

These problems often come from the way teachers teach. A lot of teachers stress memorizing facts instead of grasping concepts, which makes it harder for students to use maths in real-life situations (Boaler, 2016; Hiebert & Grouws, 2007). Large class numbers and a lack of teaching materials make it hard to give individualized instruction, which means that students who are having trouble don't get enough help (UNESCO, 2014; OECD, 2016). The lack of hands-on learning tools makes students less interested, even though manipulatives and visual aids have been shown to greatly improve understanding (Clements & Sarama, 2009; Carbonneau et al., 2013).

Differences in income and social status make things much harder. Students from low-income families typically don't have access to good early maths education or parental support, which makes success disparities even worse (Reardon & Portilla, 2016; Duncan et al., 2007). Language barrier makes learning much harder, especially for English language learners who have trouble understanding arithmetic terms and word problems (Moschkovich, 2012; Prediger et al., 2019). These problems get worse

when the curriculum moves too quickly, because students often go on to more complex topics before they have mastered the basics, leaving them with gaps in their knowledge (National Mathematics Advisory Panel, 2008; Bailey et al., 2020).

To deal with these problems, adjustments must be made. Research supports teaching methods that put the student at the centre, such as inquiry-based learning and using manipulatives, to help students comprehend things better (Hiebert & Grouws, 2007; Carbonneau et al., 2013). Professional development programs can give instructors tools to help students who are anxious about maths and make their lessons better (Geist, 2010; Beilock & Willingham, 2014). Also, policymakers need to put fair resource distribution, reduced class sizes, and early intervention programs for at-risk learners at the top priority to accomplish (OECD, 2016; Reardon & Portilla, 2016).

The difficulties in mathematics education at the basic level stemmed from abstract concepts, ineffective pedagogical approaches, linguistic obstacles, inflexible evaluations, and socio-economic disparities. Resolving these difficulties necessitated contextually adaptive pedagogy, ongoing teacher development, and a learner-centred curriculum that established firm conceptual foundations for future instruction.

1.2 Mizo Culture: An Overview

The Mizo culture is a vibrant and intricate component of the tribal legacy of Northeast India, distinguished by its own customs, social frameworks, and creative manifestations. The Mizos, predominantly residing in Mizoram, possess a unique identity influenced by their historical experiences, geographical isolation, and deep communal beliefs. Their civilization is fundamentally based on communal living, with the village (veng) as the foundation of social, political, and economic existence. Historically, the Mizos engaged in shifting cultivation (jhum), a subsistence agricultural method that supported their economy for millennia (Pachuau, 2014). This farming approach ensured food security and impacted their seasonal celebrations and community labour arrangements. The Mizo people hold their language, Mizo language (ṭawng), in high regard; it is part of the Tibeto-Burman linguistic family and acts as a cohesive element among various sub-tribes (Lalthangliana, 2005).

Music and dance are essential to Mizo cultural expression, fulfilling both artistic and social roles. Traditional dances, including Cheraw (bamboo dance), Khuallam (a ceremonial group dance), and Chheih Lam (a celebration dance with rhythmic chanting), are showcased during festivals and community meetings (Zama, 2018). These dances function not just as entertainment but also as a method of conserving history, strengthening social connections, and transmitting ancestral wisdom. The Cheraw is a visually captivating dance in which performers skillfully navigate clapping bamboo sticks, representing harmony and accuracy (Lalnunziri, 2017).

Religion has significantly influenced the development of Mizo society. Before the entrance of British missionaries in the late 19th century, the Mizos adhered to animistic beliefs, praising nature spirits (ramhuai) and engaging in rituals to placate them (Sangkima, 2004). The advent of Christianity, namely Presbyterianism, in the 1890s instigated significant transformations, encompassing the embrace of Western education, the implementation of the Roman script for the Mizo language, and the establishment of new social values (Pachuau, 2014). Currently, Christianity is intricately woven into Mizo culture, with the predominant portion of the people identifying as Christian. Churches function as venues for worship as well as centres for community engagement, education, and social services (Verghese, 1996). Although the prevalence of Christianity, traces of pre-Christian beliefs endure in folklore, superstitions, and traditional healing methods, illustrating a syncretic cultural development (Lalremruata, 2019).

Festivals serve as a dynamic manifestation of Mizo cultural identity, integrating agricultural customs, religious influences, and communal festivities. The principal festivals are Chapchar Kut, Mim Kut, and Pawl Kut, each signifying distinct stages of the agricultural cycle. Chapchar Kut, celebrated in March following the deforestation for jhum farming, is a period characterised by eating, dancing, and singing (Chib, 2016). Mim Kut, celebrated in August or September, commemorates ancestors and includes sacrifices from the initial crop (Lalnunziri, 2017). These celebrations underscore the Mizos' profound relationship with nature and their

agricultural heritage. In current times, these events have included contemporary features, like beauty pageants and music competitions, illustrating the adaptable aspect of Mizo culture (Zama, 2018).

The Mizo diet illustrates their dependence on locally sourced products and conventional culinary techniques. Staple meals comprise rice, bamboo shoots stew (mautuai bai), smoked meat (sa-rep), and fermented fish. Traditional Mizo cuisine prominently features dishes such as bai (a vegetable stew with herbs), sawhchiar (rice prepared with meat), and vawksa rep (smoked pork) (Lalthanmawia, 2020). Smoking and fermenting are prevalent preservation methods, evolved from the need in the humid environment of Mizoram. In Mizo culture, food transcends mere nutrition, embodying hospitality and communal sharing. Traditional feasts at festivals and rituals strengthen social bonding and reciprocity (Chib, 2016).

Traditional garments are a vital component of Mizo identity, with handwoven fabrics being essential. Women wear the puan, a wrap-around skirt adorned with elaborate motifs, and the kawrchei, a blouse, while males wear the puanchei (a shorter garment) and a coat (kawrchung) for formal events (Lalhmingliani, 2018). Every design and shade in Mizo weaving has symbolic significance, frequently denoting tribal identity, social hierarchy, or aspects of nature. Weaving is a respected craft among Mizo women, transmitted through generations, and handloom items are esteemed in both traditional and contemporary settings (Chib, 2016).

The social structure of Mizo culture prioritises egalitarianism, reverence for elders, and collaborative decision-making. Traditional government was implemented by village councils, where chiefs (lal) and elders adjudicated conflicts and upheld order (Nunthara, 2001). Currently, although the official government adheres to India's democratic framework, community organisations such as the Young Mizo Association (YMA) are essential in safeguarding traditional values, coordinating social welfare initiatives, and fostering discipline. The YMA, established in 1935, is a prominent civil society organisation in Mizoram, engaged in disaster assistance, moral enforcement, and cultural preservation (Pachuau, 2014).

Notwithstanding swift modernisation and urbanisation, the Mizo people have effectively maintained their cultural legacy via oral traditions, folklore, and organised initiatives. Folklore, encompassing stories such as Chhura and Nahaia, persists in narration, preserving the knowledge and history of ancestors (Lalremruata, 2019). Modern Mizoram is witnessing an increasing enthusiasm for the revival of traditional crafts, music, and dance, ensuring that future generations maintain a connection to their heritage. The state's elevated literacy rate, among the highest in India, has further enabled the documenting and scholarly examination of Mizo culture (Sangkima, 2004).

Mizo culture represents a dynamic heritage that harmonises continuity with transformation. The Mizos have preserved their own identity via language, festivals, arts, and social structures while accepting modernity. Their capacity to adapt while preserving their fundamental principles renders Mizo culture a notable illustration of perseverance and cultural pride in Northeast India.

1.3 Culture and Mathematics: An Ethnomathematical Perspective

The multidisciplinary topic of ethnomathematics examines the connection between mathematics and culture, focusing on how various civilisations acquire and apply mathematical knowledge in their day-to-day activities (D'Ambrosio, 1985). By recognising that mathematical thought may take many different forms across cultural boundaries, this viewpoint challenges the conventional Eurocentric understanding of mathematics (Barton, 1996). A rich example of ethnomathematics may be found in the ancient customs, agricultural systems, weaving patterns, and numerical ideas that are ingrained in the cultural history of the Mizo people, an indigenous group in Northeast India. This study looks at the ethnomathematical components of Mizo culture, emphasising how their customs, social institutions, and everyday activities are entwined with mathematical knowledge.

Due in large part to the work of Ubiratan D'Ambrosio (1985), who emphasised that mathematics is a result of social and cultural settings rather than a universal, culture-free subject, ethnomathematics became a recognised topic of study in the late

20th century. In order to incorporate them into a more comprehensive mathematical education, ethnomathematics aims to identify the mathematical practices of many ethnic groups, especially indigenous populations (Rosa & Orey, 2011). Given that every community has distinct methods for measuring, quantifying, and solving problems, this method encourages cultural inclusion in mathematics education (Powell & Frankenstein, 1997).

The Mizo people, predominantly located in the Indian state of Mizoram, have a unique cultural identity influenced by their historical background, language, and traditions. Their traditional knowledge systems, encompassing weaving, agriculture, and folklore, embody implicit mathematical notions that demonstrate their cognitive and practical interaction with mathematics (Lalchhunga,2018). A notable instance of ethnomathematics in Mizo culture is shown in their traditional weaving patterns. Mizo women are celebrated for their elaborate textile designs, featuring geometric symmetries, numerical patterns, and spatial logic (Zama, 2013). The Puan, a traditional Mizo shawl, has repeated geometric designs that illustrate a mastery of transformational geometry, encompassing translations, cycles, and reflections (Lalrinawma,2015).

The weaving process necessitates mathematical reasoning, including thread counting, symmetry preservation, and proportion calculation. The weavers employ a base-5 counting method for loom setup, illustrating a pragmatic numerical system tailored to their requirements (Chhakchhuak, 2017). This corresponds with the extensive ethnomathematical insight that several indigenous societies formulate counting systems derived from body digits (fingers and toes), resulting in quinary (base-5) or vigesimal (base-20) systems (Ascher, 1991). Also, the colour patterns in Mizo textiles adhere to combinatorial arrangements, wherein weavers instinctively utilise permutations and combinations to produce visually appealing designs (Zama, 2013). This indicates an inherent comprehension of discrete mathematics, although not explicitly expressed in Western mathematical terminology.

Numerous indigenous societies used mathematics in art, architecture, and handicraft. The Incas employed quipus—knotted cords—as an advanced accounting

system for census statistics, trade documentation, and narrative storytelling (Urton, 2003). This revealed their sophisticated comprehension of arithmetic and data organisation without a written manuscript. The Yoruba people of West Africa established a sophisticated numeric system founded on subtraction and modular arithmetic, facilitating efficient mental calculations in commerce (Zaslavsky, 1973). These examples demonstrated that formal mathematical notation was unnecessary for sophisticated numerical thinking. Aboriginal societies in Australia employed spatial reasoning and symmetry in sand paintings and rock art, storing geometric knowledge transmitted verbally across generations (Harris, 1987). Their comprehension of patterns and spatial linkages demonstrated that mathematical reasoning manifested in forms beyond textual equations. Polynesian navigators depended on a sophisticated comprehension of geometry, wave dynamics, and astronomical phenomena to navigate the Pacific Ocean without equipment. Their star compass system segmented the horizon into directional divisions, indicating an empirical understanding of angles and bearings (Gladwin, 1970). Ancient Indian astronomers employed exact trigonometric calculations to forecast eclipses and planetary motions, as documented in the Surya Siddhanta (Plofker, 2009). These acts demonstrated the profound interconnection between mathematics, survival, religion, and cosmology. Diverse civilisations devised unique numeric systems tailored to their needs. The Mayans had a vigesimal system, with a sign for zero, which was essential for their astronomical calendars (Aveni, 2001). Simultaneously, the ancient Chinese suanpan (abacus) facilitated efficient arithmetic processes in trade, illustrating the impact of instruments on mathematical advancement (Martzloff, 1997). These mechanisms were not simple but rather very effective within their cultural frameworks.

Studies indicate that students get superior performance when mathematical ideas are presented within culturally relevant situations (Rosa & Orey, 2011). Acknowledging the significance of indigenous mathematical knowledge fosters cultural pride and mitigates the marginalisation of traditional knowledge systems (Powell & Frankenstein, 1997). Ethnomathematics functions as a mechanism for decolonising education and empowering indigenous populations (D'Ambrosio, 1985).

The ethnomathematical approach demonstrated that mathematics is a universal human endeavour, manifested in many forms throughout cultures. By acknowledging their contributions, academics and educators fostered a more comprehensive comprehension of mathematical knowledge. This method also contributed to the preservation of endangered indigenous knowledge systems, guaranteeing that future generations recognise the richness and diversity of human mathematical thought (Barton, 1996).

1.4 Lesson Planning in Mathematics

Mathematics lesson planning constitutes the cornerstone of effective instruction and student comprehension. Educators meticulously construct courses to facilitate students' comprehension of mathematical topics and enhance their problem-solving abilities (Smith & Stein, 2011). An effective lesson plan has explicit objectives, stimulating activities, and evaluative methods that correspond with curricular requirements (National Council of Teachers of Mathematics [NCTM], 2014). Studies indicate that deliberate preparation markedly enhances student performance in mathematics (Hattie,2009). The initial phase of lesson planning entails establishing precise learning objectives. These objectives outline the knowledge and skills students are expected to acquire by the conclusion of the class (Marzano, 2007). For instance, a class on fractions may state the objective: "Students will accurately add and subtract fractions with common denominators at an 80% proficiency level." Explicit objectives assist educators in concentrating their teaching and enable students to comprehend their learning expectations (Popham, 2011). The objectives must be quantifiable and attainable within the course duration (Borich,2017).

Educators initiate classes by engaging students' existing knowledge. This method facilitates students' integration of new knowledge with their existing understanding (Bransford et al., 2000). A teacher may start a geometry session by prompting learners to recognise objects inside the classroom or to recollect prior lectures about angles (Boaler, 2016). Studies demonstrate that establishing these linkages enhances comprehension and recall of mathematical topics (Sousa, 2015).

Captivating initiators, such as riddles or practical dilemmas, can ignite students' enthusiasm for the lecture (Lemov,2015).

The primary emphasis of the class is on imparting new concepts via direct instruction and guided practice. Educators employ diverse methodologies reliant upon the subject matter and the requirements of the students (Van de Walle et al., 2013). Visual aids, manipulatives, and technology facilitate the concretisation of abstract notions (Clements & Sarama, 2014). Algebra tiles illustrate the resolution of equations, whereas fraction circles represent equal fractions (NCTM, 2014). Research indicates that experiential activities enhance mathematics comprehension, particularly for visual and kinaesthetic learners (Roschelle et al., 2010). Effective mathematics instruction provides students with the opportunity to practise newly acquired abilities. Educators facilitate guided practice with assistance before students engage in autonomous work (Fisher & Frey, 2014). Problems ought to go from easy to complicated, enabling pupils to cultivate confidence (Small, 2017). Cooperative learning activities, including students collaborating in pairs or small groups, promote debate and peer instruction (Slavin, 2011). Research indicates that articulating their thought processes enhances students' comprehension of mathematical subjects (Webb et al.,2014).

Evaluation happens continuously during the lecture to ascertain comprehension. Formative assessment methods, including inquiry, observation, and brief quizzes, yield prompt feedback (Black & Wiliam, 2009). Educators utilise this knowledge to modify their teaching, offering more examples or clarifications as necessary (Wiliam, 2011). Exit tickets, in which students respond to a concluding question before departing class, assist educators in assessing if pupils achieved the lecture goals (Brookhart, 2010). Consistent evaluation guarantees that pupils comprehend ideas prior to advancing to more complex subjects (Hattie, 2012). Lesson closure consolidates essential concepts and aids students in structuring their understanding. Educators encapsulate key concepts and resolve any outstanding enquiries (Hunter, 2004). Students may articulate concepts in their own terminology or resolve a concluding issue to show comprehension (Lemov, 2015). Reflection exercises facilitate students' analysis of their learning processes and the identification

of areas for enhancement (Zakrzewski, 2013). Effective closures enhance retention of lesson material and equip students for further learning (Marzano,2007).

Homework offers supplementary practice but must be significant and intentional (Vatterott, 2018). Studies indicate that brief, concentrated tasks are more efficacious than prolonged, repeated activities (Cooper et al., 2006). Problems ought to compel pupils to utilise knowledge innovatively rather than merely reiterate classroom exercises (Boaler, 2019). Educators must take into account pupils' household resources when assigning tasks to guarantee equity (NCTM,2014). Differentiation guarantees that all students can engage with the mathematics curriculum. Educators adjust their teaching methods according to students' readiness levels, interests, and learning profiles (Tomlinson, 2014). This may entail presenting fewer complex issues for students who are struggling, while giving extensions for advanced learners (Small, 2017). Visual aids, phrase structures, or bilingual dictionaries facilitate comprehensive participation for English language learners (Moschkovich, 2012). Differentiated education fosters an inclusive classroom environment conducive to the success of all children (NRC,2001). Technology augments mathematical instruction when employed intentionally. Digital instruments such as graphing calculators and geometry software enable students to engage with topics interactively (Cheung & Slavin, 2013). Digital platforms offer instantaneous feedback and personalised learning experiences (Roschelle et al., 2010). Technology should enhance, not supplant, conceptual knowledge (NCTM, 2014). Educators must use instruments that correspond with instructional goals and promote mathematical cognition (Borich, 2017).

The classroom atmosphere profoundly influences mathematics learning. Educators establish environments that encourage pupils to embrace risks and learn from errors (Boaler, 2016). Positive reinforcement and growth mindset techniques promote perseverance in the face of tough circumstances (Dweck, 2006). Exhibiting student work and mathematical references throughout the classroom enhances learning (Lemov, 2015). Studies indicate that supportive classroom environments enhance student engagement and performance in mathematics (Hattie, 2009). The cultural

significance enhances the relevance of mathematics for a varied student population. Educators relate topics to the lives and communities of students (Gay, 2010). Practical applications, such as computing sports statistics or creating floor layouts, illustrate the use of mathematics (NCTM, 2014). Culturally sensitive pedagogy affirms students' origins while enhancing quantitative comprehension (Moschkovich, 2012). Research demonstrates that pertinent circumstances enhance student motivation and performance (Boaler, 2016).

Collaborative professionalism enhances lesson planning. Collaborative teachers can exchange ideas and enhance instructional practices (DuFour et al., 2008). Professional learning communities examine student work to enhance instructional methods (Hord, 2009). Observing colleagues' courses offers innovative methods for conveying mathematical topics (City et al., 2009). Collaborative planning guarantees uniformity across classes while accommodating distinct teaching methodologies (Wil iam,2018). Reflection enhances educators' mathematics education. Following each class, educators evaluate the effective elements and potential modifications (Schön, 1983). They analyse student work and assessment data to judge comprehension (Brookfield, 2017). Reflection enhances planning and improves instructional efficacy over time (Marzano, 2007). Professional development programs ensure that educators remain informed about optimal methods in mathematics instruction (Darling-Hammond et al.,2017).

Effective mathematics lesson planning needs time and deliberation. Educators must reconcile curricular mandates with the needs and interests of pupils (NCTM, 2014). Carefully structured classes include students in significant mathematical reasoning and problem-solving (Smith & Stein, 2011). Studies regularly demonstrate that high-quality education enhances student performance in mathematics (Hattie, 2012). Teachers meticulously design learning experiences that cultivate both abilities and conceptual comprehension (Van de Walle et al., 2013).

Lesson preparation is a fundamental competency for mathematics educators across all tiers. Structured courses facilitate the development of mathematical knowledge, ranging from basic arithmetic to advanced algebra (NRC, 2001). As

educational research progresses, lesson design increasingly integrates new insights on optimal mathematics learning strategies for children (Boaler, 2019). Educators who invest time in meticulous planning furnish their pupils with the firmest basis for mathematics achievement (Hattie, 2009). Investing in meticulous lesson planning yields significant benefits in student learning and accomplishment (Marzano, 2007).

1.5 Ethnomathematical Lesson Plans: Integration with Mizo Cultural Components

Ethnomathematics, as a pedagogical concept, underscores the relationship between mathematics and culture, promoting the integration of indigenous knowledge and practices into mathematics instruction (D'Ambrosio, 1985). In this context, the cultural history of indigenous tribes such as the Mizos of Northeast India serves as a significant educational asset. The Mizo society possesses profound traditions, including crafts, agriculture, building, and ceremonies that are inherently mathematical. Incorporating these cultural elements into lesson designs promotes contextual comprehension, reinforces identity, and increases participation (Rosa & Orey,2007).

Ethnomathematical lesson plans start with the identification of culturally pertinent activities that use mathematical concepts. Mizo culture encompasses several fields, including weaving, bamboo crafting, home construction, traditional games, agriculture, and clan structures, offering numerous avenues for exploration. These domains encompass ideas including measurement, pattern, symmetry, spatial reasoning, categorisation, and estimation (Gerdes, 1994). When students interact with mathematical concepts that mirror their surroundings and cultural background, they link abstract ideas to known reality, promoting significant learning (Meaney et al., 2007; Mukhopadhyay & Greer, 2002).

Integrating these assets into lesson plans enhances students' comprehension of mathematics through familiar situations while cultivating a feeling of identification and pride in their cultural background. Various baskets, such as Arbawm (chicken basket), fawng (square base little basket), and Pai Em / Emping (closed weave carrying

basket), allow students to investigate polygonal patterns, angles, and transformations throughout their studies. The production of puan (traditional handwoven fabrics) like puanchei and puandum necessitates algebraic thinking, sequences, and symmetry (Zohmingthangi, 2018). The weaving process involves thread counting, pattern alternation, and sequence planning, which are intrinsically linked to ideas such as arithmetic progression and arrays. Lesson plans centred on this concept may ask students to replicate pattern sequences with coloured grids or to compute the number of threads necessary for a certain design, so incorporating both pattern recognition and multiplication techniques.

Mizo bamboo baskets serve as a significant traditional mathematical instrument. Constructed with elaborate methods over centuries, these baskets exhibit various forms and sizes, each with distinct practical and symbolic significance. The construction necessitates exact geometric computations, spatial reasoning, volume estimation, and the application of symmetry and proportion (Lalramnghaki, 2020; Vanlalchhuanawma, 2018). The circular openings of paikawng (open wave carrying basket) and emping (close wave carrying basket) necessitate that the weaver segment the circumference into regularly spaced divisions to achieve balance, demonstrating a grasp of division, radius, and angular measurement. Bamboo strips are interlaced at precise angles, often 45° or 60°, to enhance both structural integrity and visual attractiveness, directly relating to the principles of angles and tessellation (Ascher, 1991; Eglash, 2002).

A mathematics lesson utilising a bamboo basket might emphasise the computation of surface area and volume, investigate the utilised shapes (cylinders, cones, frustums), or examine the conversion of flat bamboo strips into three-dimensional structures. Students may quantify a physical basket, approximate the materials required for its fabrication, and design scale models utilising paper or software. This not only reinforces principles of geometry and measuring but also affirms the mathematical acumen inherent in traditional handicraft (Zaslavsky, 1996; Barton, 1996).

Lesson planning may include students conducting interviews with local craftspeople, gathering data on basket varieties, and categorising them according to dimensions or functionality. For instance, the Fairel Bel (An Earthen Vessel or Cleaned Rice Vessel), utilised for grain storage, is larger and exhibits a cylindrical form with a square base and circular opening. Conversely, the Chingal Thlawr Bel (Leaching Funnel), employed for soap production for washing, features a circular opening and a conical body shape. These categorisation activities encompass data management, statistical analysis, and problem-solving, while promoting community involvement (Saxe, 1991; Knijnik, 2002). These lectures respect both the custodians of cultural knowledge and the mathematical principles inherent in daily life. Traditional Mizo dwellings were predominantly built with bamboo and timber, employing functional geometry and proportion. Lessons centred on residential building may encompass the calculation of area, perimeter, and angles such as 30°, 45°, 60°, 90°, among others, as well as measurements of roof beams and similar elements. Students may be assigned architectural tasks, such as the drawing of floor plans or the estimation of required materials, utilising conventional measurement techniques (Gerdes, 1988). These challenges connect measuring with practical problem-solving, spatial thinking, and comprehension of scale. The use of body-based or bamboo-stick-based measurement units by elders exposes non-standard units and prompts discourse on the evolution of measurement systems (Fasheh, 2000).

Pedagogical methodologies in these lesson plans must correspond with Mizo cultural values, including collaborative engagement, narrative tradition, and apprenticeship-based learning. Educators may employ group projects, practical activities, and collaborative storytelling to promote culturally responsive education (Gay, 2010; Smith, 1999). For instance, students could undertake community-based projects, including the collection of housing measurements or conducting interviews with elders on agricultural practices. This approach affirms indigenous epistemology and fosters reverence for communal knowledge.

The National Curriculum Framework (NCERT, 2005) promotes the enhancement of education to be more inclusive and attuned to local settings from a

policy standpoint. Ethnomathematics corresponds with the objectives of the Indian Education Commission (1964–66) and the National Education Policy (2020), which prioritised culturally relevant and experiential learning. Integrating within cultural contexts promotes fairness, inclusivity, and significant learning results (NCERT, 2005; NEP, 2020: Ch-1, sec-4, clause 4.6).

Ethnomathematical lesson development necessitates intentional collaboration among educators, local craftspeople, elders, and cultural specialists. Interacting with local weavers, bamboo artisans, and agriculturists enables educators to acquire genuine information and transform it into suitable learning modules for students. This partnership guarantees that the curriculum is both contextually relevant and educationally robust. Curriculum designers want to incorporate modules such as "Patterns in Bamboo Crafts," "Symmetry in Mizo Textiles," or "Traditional Measurements and Estimation." These courses will correspond with the mathematics curriculum while concurrently grounding lessons in Mizo culture and principles.

In conclusion, including Mizo cultural elements into mathematics education via ethnomathematical lesson plans promotes culturally responsive teaching, increases student engagement, and deepens conceptual comprehension. It advocates for inclusive education by seeing indigenous knowledge systems as legitimate and significant. Researchers such as Rosa and Orey (2016) have emphasised that mathematics should not be regarded as culture-free but rather as a human endeavour shaped by cultural norms. Incorporating Mizo cultural artefacts and practices in the classroom allows learners to recognise their identities within the curriculum and to comprehend that mathematics is not only an abstract discipline but an integral aspect of their cultural identity.

1.6 Rationale of the Study

1.6.1 Existing Knowledge

The field of ethnomathematics, which focuses on how culture and mathematics interact, has grown in prominence throughout the last several decades.

Ethnomathematics, first used by Brazilian mathematician Ubiratan D'Ambrosio in 1985, describes mathematical practices within different ethnic groups, typically in ways that are under-represented in traditional classroom mathematics. Mathematical concepts encoded in indigenous knowledge systems through social structure, rituals, handicraft, and everyday behaviours are the focus of this area of study. It challenges the idea that mathematics is an objective, culture-neutral science by focusing on the field as a cultural product. Every culture has its unique mathematical system that has evolved to meet the demands of its society and environment (Barton, 2008). Traditional Mizo methods, like those of many indigenous societies, include mathematical reasoning, although these are frequently neglected in official schooling.

Not only is it important to preserve indigenous knowledge, but it may also help pupils become more engaged with and successful in mathematics, according to scholars (Ladson-Billings, 1995; Gay, 2010). Based on their everyday actions, including weaving, farming, fishing, and house-building, tribal people in India have developed distinctive ways of seeing space, patterns, dimensions, and numbers (Chahine, 2011; Mukhopadhyay & Greer, 2001). Mathematical methods are deeply ingrained in the arts, architecture, bamboo works, and festivals of the Mizo people, who live mostly in Mizoram and certain regions of northeastern India. One example is the bamboo-based housing constructions and traditional Mizo baskets (emping, kho, paikawng, etc.) that showcase highly developed spatial reasoning, symmetry, and geometry that have been handed down through the ages without any written records (Lalhriatpuii, 2016).

Students often do better when mathematical material is connected to their cultural origins, according to research in ethnomathematics among different tribal communities in India and elsewhere in the globe. If students feel less alienated from school when the curriculum is disconnected from their real-life experiences, culturally responsive mathematics education can help (Rosa and Orey, 2010). This chasm is far wider among indigenous communities, as education has always been a product of colonisation rather than natural progression (Joseph, 2009). The traditional knowledge and learning processes of the Mizo people are well-suited to an ethnomathematical

framework because they are highly experiential, culturally grounded, and based on direct experience.

The merits of including ethnomathematics in educational programs have been established by several studies conducted on a global scale. As an example, Lipka et al. (2005) showed that students in Alaska had far better results when taught mathematics using a culturally-based curriculum that drew on Yup'ik traditional knowledge. In a similar vein, Gerdes (1994) demonstrated how African art forms like basket weaving might teach basic ideas in geometry and topology. Despite the success of such initiatives on a worldwide scale, there is a dearth of studies focusing on Northeast India, and Mizoram in particular. Although there have been anthropological investigations into Mizo practices, ceremonies, and culture (Zawla, 1976; Lalthangliana, 2001), the mathematical knowledge systems of the Mizo people have received very little scholarly attention.

Maths in Mizoram schools is still taught according to a national or state board-mandated curriculum that leaves little opportunity for cultural or contextual understanding. The Mizo way of life incorporates indigenous knowledge, particularly in mathematics, which this standardised method may disregard. This, according to research (Nielsen & Nicol, 2005), causes students to lose interest and helps push indigenous knowledge to the sidelines. Disparities in schooling are exacerbated because different methods of knowing are not adequately acknowledged due to the cultural divide between traditional practices and classroom mathematics. To produce more inclusive and representational pedagogies, recent studies in educational research have started to emphasise the need to include local crafts, languages, and practices in learning materials. Indigenous knowledge systems should be recognised as valid systems of knowledge, argue Semali and Kincheloe (1999). One remarkable example is the bamboo artistry of the Mizo people. Using basic arithmetic, geometry, and proportional reasoning, often without standardised tools, the precise measurement and cutting techniques are used to make items like tawlhlohpuan (traditional Mizo cloth), fairel bel (grain storage), and bamboo huts (Lalbiakzuali,2020).

Culturally relevant pedagogy and constructivism are two theoretical frameworks that advocate for incorporating students' cultural backgrounds into the learning process. Ethnomathematics is a logical outgrowth of Vygotsky's social constructivism (1978), which posits that knowledge is built via interaction within a cultural setting. Banks (2006) argues that in order to promote educational justice, multicultural education must acknowledge students' cultural experiences. Incorporating Mizo cultural knowledge into mathematics teaching is therefore consistent with social justice and constructivist tenets. Local knowledge should be included in school curricula for both academic and policy-level reasons. Both the National Education Policy (NEP, 2020) and the National Curriculum Framework (NCERT, 2005) in India have placed great emphasis on contextualised learning and the incorporation of indigenous knowledge systems. This study has the potential to impact curriculum development and teacher training in tribal regions like Mizoram, as the NEP 2020 specifically calls for education to be more grounded in Indian ethos and culture.

Language is another critical component. Formal education typically uses English or Hindi as its medium of teaching, which is distinct from the local Mizo language and might further complicate matters when it comes to understanding. Because of the centrality of language to mathematics comprehension, research has demonstrated that instruction in the mother tongue considerably improves academic performance and cognitive growth (Cummins, 2000).

Few schools include ethnomathematics in their curricula, even though the importance of culture in the classroom is becoming more widely recognised. It is common for educators to be unprepared to recognise indigenous knowledge systems, verify their accuracy, and incorporate them into their lessons (Meaney, Trinick & Fairhall, 2013). There may be a lack of tools and methods to bridge Mizo cultural knowledge with the formal mathematical curriculum in teacher preparation programs. Bridging this gap has the potential to improve education for all parties involved and foster a sense of cultural pride and continuity.

1.6.2 Knowledge Gap

Ethnomathematics is recognised globally, however, there is a deficit in documenting and integrating the mathematical knowledge of indigenous people in India, notably the Mizo tribe. While D'Ambrosio (1985) and Gerdes (1994) showed the importance of cultural practices in mathematical comprehension. The Mizo tribe in India is understudied in ethnomathematics, which has just lately begun to study indigenous cultures. A large store of mathematical techniques is hidden in Mizo weaving, bamboo building, handicrafts, agriculture, and oral traditions (Lalbiakzuali, 2020; Lalhriatpuii, 2016).

Indian ethnomathematics research has been focused on mainland tribes like Bhil, Gond, and Santhal (Mukhopadhyay & Greer, 2001), with less attention given to Northeastern tribes with distinct cultural and historical backgrounds. Through their bamboo artistry, precision agriculture, and geometric textile patterns, the Mizo people display ancient mathematical understanding in daily life. These methods are not taught in formal education and are not included in the maths curriculum (Zawla, 1976; Lalthangliana, 2001). Thus, Mizo students typically struggle with maths since their lives don't match what they learn in school (Banks, 2006; Gay, 2010). Current mathematics instruction in Mizoram follows a standardised national curriculum, frequently in non-Mizo languages, without cultural modification (NEP, 2020; NCERT, 2005). While the National Education Policy 2020 promotes indigenous knowledge in schools, there is no empirical study or curriculum development model based on the Mizo tribe's mathematical viewpoint. Lack of research hinders culturally responsive education, which has been successful in indigenous communities like Alaska's Yup'ik and New Zealand's Māori pupils (Lipka et al., 2005; Meaney, Trinick, & Fairhall, 2013).

Few teacher preparation programs equip teachers to include ethnomathematical knowledge in formal instruction. Mizo instructors typically use textbooks without sufficient documentation or research-based frameworks, missing the chance to translate abstract mathematical concepts into students' cultural settings (Chahine, 2011). Language impacts understanding and mathematical cognition, but no

large research has mapped Mizo mathematical statements' linguistic aspects (Cummins,2000). Thus, research and practice on validating, documenting, and integrating Mizo traditional knowledge into mathematical instruction are lacking. The mathematical aspects of Mizo culture and how to combine them into meaningful, culturally relevant mathematics training are explored in this study to address that gap.

1.7 Need and Significance of the Study

Mathematics is generally considered a universal language, yet culture heavily influences its teaching and learning (D'Ambrosio, 2001). The Northeast Indian Mizo tribes have a rich cultural past, including distinct mathematical techniques in their everyday life, crafts, and knowledge systems. However, mainstream mathematics education typically ignores indigenous mathematical principles, disconnecting formal schooling from students' lives (Barton, 1996). The Mizo tribes' ethnomathematical traditions are explored in this work to integrate culturally relevant mathematical knowledge into formal schooling. It is becoming clear that culturally sensitive education improves mathematics knowledge, especially among indigenous pupils (Lipka et al., 2005).

This study was motivated by tribal students' recurrent underperformance in mathematics on national examinations like the National Achievement Survey (NAS) and the Annual Status of Education Report. Tribal students, particularly the Mizo, struggle with abstract maths ideas in school (ASER Centre, 2018). The curriculum's contextual insensitivity to indigenous knowledge systems may explain this (Pradhan, 2017). Ethnomathematics, suggested by Ubiratan D'Ambrosio (1985), promotes cultural mathematics to enrich student learning. This research documents and analyses Mizo mathematical activities, including weaving patterns, traditional games, and agricultural measures, to show how they might increase mathematical learning.

This research affects Mizoram and other indigenous regions' curricula and pedagogy. The National Education Policy (NEP) 2020 promotes local knowledge in school curriculum to make education more accessible and relevant (Ministry of Education, 2020). The findings of this study can help policymakers and educators

create culturally relevant mathematics curricula for Mizo pupils. Tessellation and transformations may be taught using geometric symmetry and spatial logic in weaving (Gerdes, 1996). Native measurement methods like those employed in land division or basket-making can illustrate arithmetic and geometry (Ascher, 1991).

By encouraging Mizo youngsters to preserve their culture and identity, this study has societal relevance. Globalisation and Western education are eroding indigenous knowledge systems (Smith, 1999). This research validates and incorporates cultural mathematical traditions into official education, giving pupils a sense of pride and belonging and motivating them to study maths (Presmeg, 1998). Studies demonstrate that including students' cultures in the curriculum boosts motivation and performance (Gay, 2010).

This research's impact on teacher education is crucial. Mizoram mathematics instructors may not know their culture's ethnomathematical underpinnings that can help teacher training programs adapt culturally relevant teaching approaches by giving empirical evidence on Mizo mathematical practices. Based on this study, workshops and modules might help instructors make maths more accessible to indigenous pupils. It also supports global decolonisation initiatives by questioning the Eurocentric mathematics curriculum (De Freitas & Sinclair, 2014). Indigenous knowledge has long been marginalised in academia, but ethnomathematics can revive it (Orey & Rosa, 2020).

This study is needed to solve Mizo students' cultural disconnect in mathematics education and contribute to ethnomathematics research and policy. Its lessons apply to other indigenous populations facing educational issues beyond Mizoram. This research promotes fair education, cultural preservation, and tribal student accomplishment by promoting inclusive mathematics learning.

1.8 Research Questions

The study aimed to determine the three key questions as follows:

1. What kind of mathematical elements does Mizo culture have?

2. How can these elements be utilized to enhance and promote mathematics learning among students of different grades?
3. Which mathematical concepts at the elementary level would apply to the traditional activities of the Mizo tribe, and how would that be applicable in the teaching and learning process of mathematics? (As an Ethnomathematics approach)

1.9 Statement of the Research Problem

The purpose of the study was to investigate the mathematical characteristics present in the culture of the Mizo Tribes and their potential application to the field of mathematics. Thus, the study is formally entitled **'Mathematics Learning among Mizo Tribe: An Ethnomathematical Study'.**

1.10 Objectives of the Study

1. To study the mathematical elements which exist in the culture of the Mizo tribe.
2. To identify the different mathematical activities embedded among different cultural materials of the Mizo tribe.
3. To identify the connotation of mathematical concepts at the Class VIII level with existing cultural mathematical elements of the Mizo tribe.
4. To develop ethnomathematical lesson plans for Class VIII students.
5. To study the effect of ethnomathematical teaching strategies on mathematics achievements among Class VIII students.

1.11 Operational Definition of the Key Terms Used

Mathematics Learning

Mathematics learning (Verschaffel, L., Van Dooren, W., De Smedt, B.,2019) can be broadly defined as acquiring new knowledge, skills, and effects related to quantity, space, computation, numeracy, and structure.

Mathematics learning in the present study refers to the conceptual understanding of various concepts of mathematics prescribed in school mathematics textbooks.

Ethno-Mathematics

Ethnomathematics is the study of how mathematics and culture interact in mathematics education. Typically connected with "cultures without written expression", it may alternatively be defined as "the mathematics which is practiced among identified cultural groupings" (D'Ambrosio, 2001).

Ethnomathematics in the present study means the study of mathematics and its intercept on day-to-day life with the customs and culture of the Mizo tribe.

Mizo Tribe

The Mizo tribe denotes a collective of indigenous individuals mostly residing in the northeastern Indian state of Mizoram, along with adjacent areas of Myanmar and Bangladesh. They are part of the broader Tibeto-Burman language family and are recognised for their own cultural identity, traditional practices, and community way of life. Their civilisation has transitioned from a tribal chiefdom to a contemporary democratic framework (Zama, 2011). The Mizo culture is abundant in oral traditions, festivals, and artisanal skills, particularly in bamboo handicrafts. Mizoram's 95% of the population is of tribal origin. By Article 366 (25) in the Constitution of India, they have the status of a Scheduled Tribe (ST).

In the present study, Mizo tribes refer to the indigenous tribal people of Mizoram, commonly known as Mizos.

1.12 Variables of the Study

Independent Variable

The present study involves one independent variable. The teaching method, i.e., ethnomathematical teaching strategies and traditional teaching methods, served as an independent variable.

Dependent Variable

The dependent variable, which was taken as a criterion of the effect of treatment, is mathematical achievement. The purpose of obtaining the variables was to determine the alteration in students' mathematical achievement results from the treatments.

1.13 Hypotheses

Research Hypotheses

H_1: An Ethnomathematical Lesson Plan can have a significant effect on the mathematics achievement of Class VIII students

Null Hypotheses

H_0: There is no significant effect of the Ethnomathematical Lesson Plan on the mathematics achievement of Class VIII students.

1.14 Delimitations

1. The present study will be done only on Mathematics learning.
2. The present study will be done only on the Mizo tribe of Mizoram.
3. In the present study, Class VIII will only be taken for the experiment.
4. The present study will be done on the mathematical elements in the culture of the Mizo tribe only.
5. The present study is only based on the effectiveness of the ethnomathematical lesson plan.

Chapter-II

Review of Related Literature

2.1 Introduction

A literature review integrates and synthesises essential materials, hypotheses, facts, and scholarly discussions as the preliminary phase of any research endeavour. It links prior research and proposes future studies to support the present study. The researcher can establish a coherent theoretical and conceptual framework by meticulously reviewing books, peer-reviewed journal articles, reports, conference proceedings, dissertations, and other credible sources. Academic literature reviews evaluate, contrast, and integrate knowledge to determine relevance, validity, and applicability. Through critical thinking, researchers can avoid redundancy, build on prior research, and delineate the study's role within academic discourse. A thorough literature study demonstrates the researcher's expertise on the issue and capacity to identify trends, paradoxes, and patterns. The study's scope is defined by identifying what has been researched and where additional insights may be obtained. Evaluating the merits and limitations of previous studies enhances research concepts, hypotheses, and methodologies.

In the present study, the reviews were conducted across a variety of sources, including books, journals, theses, magazines, periodicals, and distinct websites. Taking into consideration the significance of the study issue, the researcher has conducted a review of ethnomathematical studies.

2.2 Review of Literature on Ethnomathematics

Fasheh, M. (1980) conducted a study entitled “Mathematics, Culture, and Authority”. The article examines the correlation between traditional cultural beliefs, cognitive processes, and behavioural patterns in connection with mathematics education, especially in developing countries. The article discusses the influence of culture on individuals' perceptions and understanding of concepts, the importance of integrating personal experiences into mathematics education to enhance its efficacy and relevance,

and the methods by which mathematics can be employed to tackle issues within one's culture and society

Panda, M. (2006) wrote an article titled “Mathematics and Tribal Children”. The article indicates that the methodology of mathematics instruction in primary schools significantly impacts the inferior performance of indigenous children in mathematics classes. Despite indigenous tribes possessing extensive knowledge in mathematics and the sciences, educational instruction is entirely removed from their lived experiences. The National Curriculum Framework, 2005, seems to lack a clear commitment to incorporate a cultural perspective in mathematics education, which is essential for preserving the self-esteem of tribal children and providing them with a meaningful education.

Zhejiang, W. Z., & Zhang, Q. (2010) conducted a study titled **“**Ethnomathematics and Its Integration within the Mathematics Curriculum”. The research illustrates the processes by which mathematics is generated, disseminated, adapted, and specialised within various cultural frameworks. Incorporating ethnomathematics into the mathematics curriculum is logical, particularly through the use of constructing techniques for "rectangle bases" favoured by the Mozambican peasantry in Africa. This essay examines the inclusion of "Ethnomathematics" in the mathematics curriculum and then analyses how vector instruction in new high school mathematics courses in China has clarified the curriculum transformation.

Arisetyawan, A., Suryadi, D., Herman, T., & Rahmat, C. (2014) conducted research to uncover the students of “Study of Ethnomathematics: A lesson from the Baduy Culture”. This paper examines the ethnomathematics of the Baduy community, emphasising their technology and fundamental concepts. Despite the Baduy people's aversion to formal schooling, their cognitive framework and principles are remarkably intriguing to examine, particularly their logical and precise anti-rat technology grounded in mathematics and theoretical physics.

D’Entremont, Y. (2014) conducted a study titled “Linking Mathematics, culture and Community”. The study highlights that the creation of mathematics activities utilising

traditional symbols from other cultures is facilitated by the persistent and growing cultural diversity within Canadian schools. To develop educational activities, it is essential to integrate mathematics, culture, and community. This essay examines how to do this while considering the cultural diversity of the students. Mathematical concepts grounded in cultural perspectives enable students to contemplate and value not just their own culture but also the cultures and traditions of others.

Abreu, G.D., & Cline, T. (2016) published an article titled "Schooled Mathematics and Cultural Knowledge". This paper argues that to acknowledge the cultural dimension of mathematics education adequately, it is essential to analyse these activities within their socio-political context. The connection between this facet of the social domain and the learner's personal development is to be comprehended through the interplay between the construction of social identities and the social representations of mathematical activities.

Rubio, J.S. (2016) wrote an article titled **"**The Ethnomathematics of the Kabihug Tribe in Jose Panganiban, Camarines Norte, Philippines". The study delineated the ethnomathematical methods employed by the Kabihug in their quotidian activities, encompassing basic counting, ciphering, measuring, categorising, ordering, inferring, and modelling patterns derived from their environment. It also offered insight into some socio-cultural characteristics of the group. Moreover, instructional materials for mathematics for Grades 7 and 8 were developed utilising the K-12 Curriculum Guide, textbooks, and modules to highlight and include the ethnomathematical traditions of the Kabihug tribe.

Septianawati, T., Turmudi, & Puspita, E. (2017) attempted to reveal "Ethnomathematics study: uncovering units of length, area, and volume in Kampung Naga Society". This study aims to determine the length, area, and volume of units employed by the Kampung Naga population. This inquiry utilised a qualitative approach and ethnographic methodologies. This research uses ethnographic methods, including observation, interviews, recording, and field notes, to gather data. The study's conclusions encompass the translation of length, area, and volume measures employed by the Kampung Naga civilisation into standard units. This study aims to

illuminate the relationship between mathematics and culture and to generate recommendations for Indonesia's mathematics curriculum.

Az-Zahroh, S.F., et al. (2019) revealed in their study that they developed ETHIC GAME, an augmented reality (AR) media that combines math and culture to improve student engagement. Based on Edgar Dale's learning theory and Ki Hadjar Dewantara's TRINGO concept (Understanding, Experiencing, Doing), the game assisted kids in grasping arithmetic concepts meaningfully while conserving cultural knowledge. Researchers used the Lee Owen development methodology to design an interactive tool that all users found easy and pleasant. The results demonstrated that combining ethnomathematics with augmented reality technology increased learning authenticity and cultural sensitivity. The study proved how innovative media can improve both math education and cultural understanding.

Ngasainao, G. & Vandana (2019) worked together for research on "Enhancing Mathematics Learning through Ethnomathematics: A Study on Tangkhul Tribe of Manipur". The current study's findings indicated that the characteristics of Tangkhul culture encompassed mathematical concepts suitable for formal instruction. Teaching approaches suitable for primary students were established based on the researched aspects that encompassed mathematical ideas. In summary, the ethnomathematics approach effectively enhanced mathematics learning at the primary level.

Prahmana, R. C. I. (2019) discussed in his study the use of ethnographic approaches to investigate mathematical concepts in cultural festival events. Data was gathered by researchers via documentation, interviews, and observation. The findings showed that geometric ideas ingrained in cultural practices included transformations, cone surface area, the Pythagorean theorem, and circle circumference. The results showed how mathematics organically arises in conventional situations, offering real-world learning contexts. This study demonstrated how cultural events can serve as a link between abstract mathematics and practical applications.

Pramudita, K., & Rosnawati, R. (2019) investigated geometric ideas in Javanese culture using artifacts such as batik motifs (Lereng, Ceplok, Jlamprang), horse-drawn

carriages, and Joglo dwellings. Mathematical elements such as lines, angles, triangles, circles, and spatial constructs were discovered by researchers using exploratory approaches with observations and interviews. The results demonstrated how geometry concepts are embedded in traditional objects, offering real-world contexts for mathematics instruction. The study illustrated how ethnomathematics might link Javanese society's cultural legacy with abstract ideas.

Singh, S., Choudhury, S. & Nongrum, B.D. (2019) conducted a study titled "Low Achievement in Mathematics, a case study of Schools of East Khasi Hills, Meghalaya: A Survey". The analysis of mathematics education has demonstrated considerable challenges. This paper reviews research studies on three essential factors—intelligence, study habits, and adjustment patterns—and their correlations with mathematical success, done by diverse experts in India and elsewhere. This paper also presents the study findings based on the three aforementioned parameters.

Yadav, S. (2019) conducted a study titled "Role of Mathematics in the Development of Society". Mathematics is a branch of science that studies numbers and the operations on them. Math, calculations, problem-solving, etc., are all necessary. According to the dictionary, mathematics is the science of measurement, amount, and size; alternatively, it is the study of numbers and space. The subject is well-structured, systematic, accurate, and logical. Quantities, structures, spaces, and changes are the main topics covered in mathematics. Mathematical analysis has progressed through the ages from its roots in counting, calculating, and measuring, as well as the study of actual things' shapes and movements via abstraction and reasoning.

Bhat, K.P. (2020) conducted a study titled "Culture, Indigenous knowledge and Mathematics Reflected on Ethnomathematics". This research seeks to examine the relationship between ethnomathematics and culturally rooted indigenous knowledge. It aims to provide a comprehensive explanation of culture and its relationship to ethnomathematics. Identifying the cultural values that influence mathematics might be beneficial.

Nur, A.S., Kartono, Zaenuri, Waluya, S.B., & Rochmad (2020) wrote an article titled “Ethnomathematics thought and its influence in mathematical learning”. The article aims to give a concise summary of the history, critique, and challenges of ethnomathematics, along with the perspectives of prominent experts in the field and their influence on contemporary mathematics teaching. Moreover, culture profoundly influences mathematics learning, and its integration requires considerable effort to overcome many barriers. To optimise the integration of ethnomathematics in the classroom, educators must enhance their understanding of the local culture.

Alangui, W.V. (2020) conducted a study and emphasised that ethnomathematics endeavours may be harmed by decontextualising cultural activities (decontextualization) or colonising them (colonisation). Dowling's theories—the myth of emancipation and the myth of reference—aided in the explanation of these threats. New Zealand and the Philippines provided examples of how well-meaning programs occasionally misinterpret local knowledge. In order to prevent cultural misrepresentation in math instruction, critics contended that a more profound and considerate approach was required. According to these results, ethnomathematics research should proceed with prudence to guarantee cultural relevance free from exploitation or distortion.

Dosinaeng, W. B. N., Lakapu, M., & Leton, S. I. (2020) conducted an ethnographic study to investigate mathematical components in the Boti Tribe's culture (calendar, lopo, and woven fabric). Number operations, geometry, and algebra, as well as problem-solving and spatial skills, were discovered in tribal traditions by researchers. The findings revealed that incorporating Boti culture can make arithmetic instruction more realistic and culturally meaningful. The study established a framework for instructors to create ethnomathematics-based lessons that preserve indigenous knowledge while improving mathematical understanding.

Pinheiro, R.C. & Rosa, M. (2020) conducted a study to investigate how ethnomathematics aids bilingual deaf students' financial education. Researchers in Belo Horizonte, Brazil, carried out qualitative research in a public school for deaf pupils. Participants were deaf pupils, both young and old, whose first language was

Libras (Brazilian Sign Language). Teacher diaries, class recordings, math activity records, and interviews were among the data. The analysis was grounded in grounded theory. Bilingual instruction and ethnomathematics enhanced deaf pupils' mathematical learning, according to the findings. The method assisted in relating mathematical ideas to actual financial situations.

Richardo, R. et al. (2020) investigated how the Islamic Nusantara culture can be integrated into mathematical education. The study used a library method, examining published journal papers. The analysis involved three stages: organizing, synthesizing, and identifying. The findings revealed that Islamic Nusantara culture helped in teaching mathematical ideas, reinforced character education, and improved cultural literacy skills. The study concluded that cultural components can enhance math teaching while protecting local values.

Zaenuri, Mukeriyanto, & Mulyono. (2020) revealed a study examining how a cooperative learning approach with ethnomathematics elements could help eighth-grade students improve their cultural appreciation and problem-solving skills. Researchers used a quasi-experimental approach using random cluster sampling to compare an experimental group (VIII D) and a control group (VIII A). The experimental group fared better than the control group, with higher average scores (77.5 vs. 67.5) and stronger improvements in cultural awareness and problem-solving ability. The results confirmed ethnomathematics-integrated cooperative learning as a successful teaching strategy.

Acharya, B.R., Kshetree, M.P., Khanal, B., Panthi, R.K., & Belbase, S. (2021) conducted a study titled "Mathematics educators' perspectives on the cultural relevance of basic level mathematics in Nepal". The primary objective of this study was to examine the perceptions of mathematics instructors in Nepal on the cultural importance of studying fundamental mathematics. The three primary themes that emerged were instruction in the mother tongue, contextualised ethnomathematics, and the incorporation of local knowledge into the curriculum as a pedagogical method. This study enhances the understanding of cultural impacts on mathematics education and curriculum design.

Janiola, F. R., & Santos, M. S. (2021) researched "The Ethnomathematics Practices of Eskaya Tribe". The research elucidated the ethnomathematical practices of the Eskaya tribe, including the procedures and methods they routinely utilise for counting, measuring, ciphering, arranging, categorising, inferring, and modelling patterns in their daily lives. The examination of the Eskaya numeration systems, including Eskaya numbers and numerals, the nomenclature of essential forms, the four basic operations, and the application of Eskaya numbers for measuring time, days, and months, all used these skills and methodologies.

Kamid, Rohati, Marzal, J., Simamora, N. N., Auliya Ramadhanti, A., & Iqbal, M. (2021) prepared a study titled "Study of Ethno-mathematics and Vygotsky's Constructivism on Jambi Traditional Marriages". This study aims to examine the mathematical elements included in the Jambi traditional wedding rite to provide knowledge applicable in educational settings. The study employed interviews, observations, and supporting documentation as its instruments. The data collected from interviews, observations, and documentation is subsequently evaluated using Miles & Huberman's analytical methods, employing a manually applied, predetermined colour coding system. The results revealed that counting, measuring, organising, producing, playing, and explaining were mathematical principles used in the Jambi traditional wedding ceremony.

Septiani, N.W.P., Irawan, A., & Wulan, R. (2022) conducted ethnographic research to examine mathematical aspects of the Sasak tribe's culture. Through observations, interviews, and documentation, researchers examined architecture, traditions, and customs. They discovered area calculations in cultural practices, flat shapes in buildings, and mathematical ideas in spatial designs. These linkages were validated by the triangulation approach, and the results were confirmed by specialists. According to the study's findings, mathematics permeates every aspect of Sasak daily life, from architecture to rituals. This demonstrated how math and culture naturally coexist in indigenous communities. Similar relationships between other ethnic groups could be investigated further.

Mansion, K. H. (2022) conducted a study on “a case study exploring ethnomathematics’ effect on students’ cultural and historical literacies in a virtual mathematics classroom”. This study aimed to assess changes in students' cultural and historical literacy after engaging in an ethnomathematics curriculum during a virtual summer STEM camp, as well as to evaluate their ability to recognise the importance of mathematics in their lives. During the virtual classroom sessions, students examined the foundational concepts of geometry, discovering how patterns are created and how mathematics is integrated into cultural traditions.

Cahyaningati, I., & Diana, H. A. (2022) conducted a study that used ethnographic approaches to investigate mathematical principles in the traditional Arul game. Researchers used literature reviews, interviews, and observation to gather data. The findings showed mathematical components such as probability, circle geometry, division, fractions, and measurements (distance, speed, and time). In addition to providing contextual learning materials, the research showed how indigenous games incorporate mathematical concepts. This study demonstrated how traditional games can improve mathematical comprehension while also conserving cultural heritage.

Iqbal & Batubara (2022) emphasised that ethnomathematics makes mathematics more understandable and relevant to students' daily lives by integrating culture into the teaching process. This approach aims to reveal analytical patterns while helping students understand and apply mathematical concepts in practical contexts. Research showed that ethnomathematics improved students' motivation, academic performance, and knowledge retention. Recognising culturally embedded problem concepts is crucial for educators designing ethnomathematics-based curricula to facilitate effective learning. The Research also supported that students engaged more deeply with mathematics when connected to their cultural experiences. The approach proved effective in creating engaging and contextualised learning environments that foster mathematical understanding and real-world application.

Nahak, R.L.& Feka, V. P. (2022) conducted a study to investigate ethnomathematical aspects of the "matamusan" tradition of the Tetun people. A qualitative-exploratory methodology was used by the researchers to observe and interview cultural

participants. Six mathematical notions were identified by them: (1) geometric shapes (such as lines, rectangles, and rhombuses); (2) counting; (3) median; (4) time units; (5) weight units; 6) currency. These results can be used to relate curriculum and culture in primary school arithmetic instruction. The study demonstrated how cultural heritage can be preserved while enhancing math instruction through local customs.

Permita, A. I., Nguyen, T. T., & Prahmana, R. C. I. (2022) conducted a study to use anthropological methodologies to investigate ethnomathematics in Javanese Gringsing batik motifs. Researchers examined batik patterns through a literature study, observation, and interviews. Gringsing designs incorporated geometric principles such as plane shapes and transformations, as well as cultural philosophies, according to the findings. The findings showed how traditional art can connect abstract numbers to real-world circumstances. This study developed culturally relevant teaching materials, which enhanced both mathematical understanding and Javanese cultural awareness in schooling.

Srivastava, S. M. (2022) wrote an article titled "Mathematics Teaching in India: Present and Future." This paper asserts that creative thinkers ought to engage with science broadly and mathematics specifically. Researchers should be afforded total autonomy in choosing their research focus. When creative intellects are allowed unrestricted liberty, science, encompassing mathematics, has consistently produced and will persist in generating advantageous contributions.

Subarinah, S., et al., (2022) conducted a study to develop a logic and sets textbook that uses Sasak ethnomathematics to improve higher-order thinking skills. Researchers used the ADDIE paradigm (Analysis, Design, Development, Implementation, Evaluation) to generate culturally based learning materials. Expert validation rated the textbook "Very Good," confirming its suitability as a learning resource. The study showed that including Sasak cultural contexts into math teaching increased conceptual knowledge while maintaining local history. The findings demonstrated ethnomathematics' ability to bridge abstract concepts and real-world applications in mathematics education.

Murtafiah, W. et al., (2022) conducted a study that used Ngawi ethnomathematics to investigate how well pupils solved geometry problems. One male and one female student from a junior high school in Ngawi, Indonesia, were the subjects of the qualitative study. Data was reduced, presented, and concluded, and validity was ensured through triangulation. The findings indicated that male students outperformed female students in plans, comprehension, and problem-solving related to ethnomathematics. Compared to female students, they provided clearer explanations of the stages and more efficient verification of results. To enhance learning, the study recommended that educators provide more culturally appropriate math problems.

Yu, H. (2022) conducted research titled "Research on the Implementation of Mathematics Culture Education in high school mathematics curriculum". The study indicates that students' values have been profoundly influenced and challenged due to the growth of Internet technology and the increasing prevalence of cultural exchanges both nationally and internationally. The sole approach for revitalising the nation and constructing society at present is to enhance students' political and ideological education. To fulfil the essential objective of fostering ethics and nurturing persons, the implementation of mathematical cultural education is vital.

Anisa, Y., Siregar, R.F., & Hafiz, M. (2023) investigate ethnomathematical principles inside Indonesia's traditional engklek game via an ethnographic methodology. The research demonstrates, via observation and recording, how cultural factors include mathematical ideas, namely in the patterns, rules, and components of the game. The findings define specific uses of two-dimensional geometry, numeration, arithmetic operations, and probability within this cultural practice. The study illustrates the inherent connection between Indonesian cultural history and mathematical reasoning, offering educators genuine examples for culturally-based mathematics education while safeguarding traditional knowledge systems via scholarly recording.

Darmayanti, R. (2023) in his investigation of Bruner's hypothesis on the evolution of e-book traditional foods ethnomathematics for enhancing mathematical comprehension skills, the project concludes the development of an ethnomathematics-based e-book that showcases traditional foods, utilising Bruner's enactive-iconic-

symbolic learning phases. The research employing the 4-D technique exhibits substantial validity (material: 3.86; media: 3.74) and practicality (82% eligibility). Student evaluations ranked the e-book 91% as "Very Effective," affirming its efficacy in improving mathematics comprehension. The findings demonstrate that this culturally-based digital resource effectively integrates traditional knowledge with formal mathematics instruction via an interactive, theory-driven design.

Dominikus, W. S., et al. (2023) Conducted research on ethnomathematics within the Caci dance of the Manggarai people and its use in mathematics education. This project aims to elucidate the history and philosophy of the Caci dance, analyse the ethnomathematics inherent in it, and provide educational aids for various mathematical principles identified inside.

Fouze, A. Q., & Amit, M. (2023) studied 'The Importance of Ethnomathematics Education'. This investigation demonstrates how cultural values, traditions, and symbols are present in every civilization's day-to-day operation. Because it influences social, religious, educational, and economic pursuits, culture plays a vital part in human existence and society. Education in general and mathematics education in particular are influenced by cultural beliefs. This article discusses the need to design and execute maths courses that embed cultural and folkloric elements and values from the students' daily lives and society, such as geometry in Bedouin embroidery. This article discusses the foundations of the ethnomathematics approach and its importance in mathematics education.

Hartini, Y., & Dafik, T. D. (2023) conducted a study to investigate how Majapahit-themed ethnomathematics using a STEAM approach could improve students' creative thinking abilities. Researchers used cardboard models of historical buildings to teach two-dimensional and three-dimensional geometry principles. The technique combined mathematical ideas with Mojokerto City's cultural features. The results demonstrated that incorporating Majapahit culture through hands-on STEAM activities increased students' ability to produce inventive solutions. The study found that culturally relevant, multidisciplinary strategies help develop 21st-century mathematics competencies.

Hendriyanto, A. et al. (2023) discussed a systematic review of ethnomathematics research (2018-2022), following the PRISMA criteria and including 24 Scopus and Eric-indexed publications. The investigations identified two major research kinds depending on data sources, with cultural forms classified as ideas, behaviours, or artefacts. The research was divided into two categories: ethnomathematics (pure) and ethno-modelling. The most frequently studied topic was geometry (n=11), followed by algebra (n=5), numbers (n=3), sets (n=2), and arithmetic (n=1). The findings indicated a growing interest in ethnomathematics, but they also revealed gaps in geographic and topic variety.

Ilmaa, Riyadia, & Usodo (2023) conducted research based on ethnomathematics that affected elementary school pupils' capacity for creative thought and enthusiasm to learn. This study employed a quantitative quasi-experiment. Multivariate normality tests, homogeneity tests of variance and covariance matrices, pretest data balancing tests, and hypothesis testing using multivariate analysis of variance are among the steps in the data analysis process. The results of the study, the hypothesis is rejected if the multivariate test output has a sig. value of 0,0001<0.05. The experimental and control groups differed in their average creative thinking skills and eagerness to learn. Hence, it can be said that interactive multimedia based on ethnomathematics had an effect on both learning motivation and creative thinking abilities at the same time.

Kusmaharti, D., Pramulia, P., & Yustitia, V. (2023) examine ethnomathematics comics of Al-Akbar Mosque Surabaya to improve numeracy and literacy in reading and writing. The study reveals the creation of ethnomathematics comics centred on Surabaya's Al-Akbar Mosque to improve primary pupils' numeracy and literacy competencies. Employing the ADDIE paradigm, namely the Analysis, Design, and Development phases, Research and Development (R&D) methodologies were used with fifth-grade students at Bahrul Ulum Elementary School. Quantitative investigation validated the comics' efficacy as an innovative educational tool. The findings indicate that culturally contextualised comics can enhance significant learning outcomes, providing educators with an effective resource to tackle reading and numeracy issues in Indonesian elementary schools.

Kusuma. D.A. et al. (2023) in their studies investigated how the Mozart effect and ethnomathematics enhanced analytical geometry students' mathematical disposition and problem-solving abilities during the COVID-19 transition. Students studying mathematics in their second semester at Universitas Padjadjaran participated in a quasi-experimental design using purposive sampling. Students who were exposed to ethnomathematics and Mozart music scored better than those who received regular teaching, according to the results, exhibiting stronger mathematical attitudes and improved problem-solving skills. They also expressed greater curiosity and drive to learn. According to the results, integrating aural stimulation with cultural context improved student engagement and academic achievement. In addressing post-pandemic learning difficulties, this creative method worked well and could serve as a template for future approaches to mathematics instruction

Nuryadi, et al. (2023) studied **'**The Effects of Puppet Ethnomathematics Applications as Mathematics Teaching Materials for Character Education-Based'. The present research investigates how students react to wayang puppet teaching materials that incorporate character education and ethnomathematics. Surveys evaluating an Android application were used to gather data from 260 junior high school students in Yogyakarta (130 low-achieving and 130 high-achieving) using quantitative descriptive approaches. The findings demonstrated that both groups thought the application was beneficial (G1: 85%, G2: 92%), simple to use (G1: 88%, G2: 90%), and fulfilling (G1: 87%, G2: 93%). No statistically significant difference in answers between groups was found ($p>0.05$). The Wayang figures demonstrated the potential of ethnomathematics for character education through culturally relevant teaching materials by successfully communicating religious, disciplined, hard-working, and patriotic qualities.

Oktaviyani, D. M., Utami, N. W., & Utama, G. Y. (2023) studied 'Number and Set Theory in Gamelan: An Ethnomathematics Study'. The present research investigates ethnomathematical notions inside gamelan artefacts as contextual learning instruments for Sets and Numbers. Data were gathered from two art studios and three Indonesian schools utilising an interpretative ethnographic technique based on Alangui's

framework, including observations, interviews, and recordings. Research indicates that the many types, forms, and dimensions of gamelan can enhance mathematics education. The study offers educators novel approaches to include cultural artefacts into mathematics instruction, connecting Javanese heritage with mathematical principles while maintaining local wisdom in modern teaching practices.

Putri, N.N.P. & Purnomo, Y.W. (2023) revealed in their study that an ethnographic study used observation, documentation, and interviews to investigate geometric notions at the Moekhlas Sidik Red Mosque. The analysis showed several 2D shapes (triangles, trapezoids, rhombuses), 3D forms (rectangular prisms), and geometric transformations (translation, reflection, rotation). The study also highlighted mathematical activities such as pattern generation and shape drawing that employ transformation principles. The findings showed how architectural features could function as authentic learning tools while also offering financial benefits to local communities. The study validated ethnomathematics approaches that link abstract concepts to culturally recognisable surroundings, providing practical models for geometry education in Indonesia.

Pradhan, J.B. (2023) emphasised in his study that the Chundaras culture was investigated through participant observation and interviews in this anthropological study, which revealed mathematical ideas ingrained in everyday activities and intergenerational learning. The findings revealed that Chundaras' mathematics was taught cooperatively through family guidance, consistent with Vygotsky's social learning theory. The study compared this interactive method to traditional school instruction, revealing a major cultural mismatch. According to the findings, conventional education frequently ignores indigenous epistemologies, which may impede cultural groups' mathematical knowledge. The study helped to expand the ethnomathematics literature by identifying distinct Chundaras' knowledge systems and calling for culturally responsive mathematics training that combines academic and indigenous learning approaches.

Richardo et al. (2023) conducted research based on an Android-based approach using AR educational materials in an ethnomathematical setting has been developed. The

media was created specifically for the purpose of pupils and aspiring math professors in the classroom and the study of geometry. This study should contribute something fresh to the realm of augmented reality-based education. The five categories of the ADDIE paradigm are analysis, design, creation, application, and assessment. With a practicality percentage of 89% based on teacher assessment and 84% based on student assessment, the multimedia was found to be in the practical category. Therefore, it can be said that the multimedia created for this study effectively enhances students' capacity for original thought.

Runtu. P.V., et al (2023) conducted a study on Students' Mathematical Literacy: A Study from the Perspective of Ethnomathematics Context in North Sulawesi, Indonesia. The Researchers at SMP Negeri 2 Tondano used ethnomathematics contexts to study pupils' mathematical literacy. Different degrees of competency were found through descriptive analysis of test and interview data. The results showed a general lack of mathematical literacy, especially when it came to understanding and using concepts. The study made clear that better teaching methods are required to help students become more adept at solving problems in practical settings. Although ethnomathematics was deemed beneficial, it needed to be further incorporated into the curriculum.

Sukestiyarno, Y. L., et al. (2023) in their study discussed that a non-Euclidean geometry is difficult for kids to learn since it is abstract. With 100 students studying mathematics education, this study used a 2×2 factorial design to examine how ethnomathematics could improve spatial abilities in Lobachevsky and Riemann geometries. After accounting for knowledge of Euclidean geometry, the results revealed that the ethnomathematics group's spatial aptitude ratings were noticeably higher than those of the standard teaching group. The successful learning trajectory included goal-setting, the presentation of visual ethnomathematical challenges, student investigation, drawing conclusions, and information exchange. Both quantitative (ANCOVA) and observational data validated the validity and dependability of the technique. These results illustrated the potential of ethnomathematics to visualise and explore abstract geometric concepts in a culturally relevant way.

Suryonegoro, B.M., & Hidayah, I. (2023) discuss The Influence of the Gedongsongo Temple Ethnomathematics Problem-Based Learning (PBL) Model on the Creative Thinking Ability of Junior High School Students in view of Self-Confidence. The present research examines the impact of an ethnomathematics-oriented Problem-Based Learning (PBL) paradigm at Gedongsongo Temple on the creative thinking and self-confidence of ninth-grade junior high school students. Data were acquired using a quasi-experimental post-test-only control approach using tests and questionnaires. The analysis encompassed tests for normality, homogeneity, proportions, and regression. Findings indicate substantial enhancements in both creative cognition and self-assurance among students engaged with the PBL paradigm. The study emphasises the necessity of transitioning from conventional teacher-centered methodologies to culturally relevant, student-centered learning to improve student engagement and cognitive growth.

Auw, E. M. E., Son, A. L., & Laja, Y. P. W. (2024) conducted a study to investigate Lego-lego dance and traditional items from the Abui group, such as the Fala foka house, Lopo, and Moko, which represent mathematical principles and cultural values. Researchers discovered geometric shapes (squares, circles, pyramids) and cultural symbols (unity, identity, cardinal directions) through anthropological approaches. Findings showed how indigenous techniques combine cultural meaning with quantitative concepts. According to the study, these links could preserve regional heritage while improving ethnomathematics-based education. These results could be used by educators to develop arithmetic classes that are culturally appropriate.

Batiibwe, M. S. (2024) examined sixty-one articles to discern cultural artefacts using mathematical themes for educators in underdeveloped nations. Research indicates that school mathematics is evident in cultural games, weaving, dances, architecture, and numerical systems, with games and weaving being the most prominent. Although global education acknowledges the significance of ethnomathematics, poor countries frequently lack the necessary support for implementation. The research advocates for the use of these cultural aspects as educational instruments, directed by the ADDIE paradigm for systematic incorporation. The results establish a basis for educators to

integrate ethnomathematics into their teaching, addressing existing curriculum deficiencies through culturally responsive mathematics education.

Bintoro, H.S., Richa Aulya, R., & Wanabuliandari, S. (2024) researched Problem-Based Learning Model Assisted with the Ethlaf Application, Containing Ethnomathematics to Improve Students' Conceptual Understanding Capability. This study investigates whether a problem-based learning strategy that incorporates ethnomathematics and ETHLAF APPS enhances students' mathematical conceptual knowledge in comparison to direct instruction. A quasi-experimental nonequivalent pretest-posttest control group approach was employed, utilising purposive sampling of high school pupils, to gather quantitative data via concept understanding assessments. Independent sample t-tests indicated that the experimental group utilising the ethnomathematics-based problem-solving technique with ETHLAF APPS achieved substantially higher average conceptual comprehension scores compared to the control group that received direct instruction. The results indicate that technology-enhanced, culturally contextualised problem-based learning more successfully cultivates mathematical conceptual understanding—a vital element of mathematics education compared to conventional direct teaching approaches.

Dasar, P.P., & Ibtidaiyah, P.P.G.M. (2024) discuss in the article Ethnomathematics-based Fraction Number E-Modules for Prospective Elementary School Teachers. This article created an ethnomathematics-based e-module for instructing fractions to alleviate students' challenges in relating abstract concepts to real-life situations. The research utilised the ADDIE methodology, namely the creation phase, engaging material and media specialists for validation, and conducting small-group testing with 12 second-semester students. The data collection encompassed observations, interviews, and questionnaires, which were analysed using qualitative and quantitative descriptive methodologies. The results demonstrated substantial validity (material expert: 97.93%; media expert: 96.66%) and practicality (student response: 90.21%). The e-module adeptly connects cultural backgrounds with fraction principles, indicating its appropriateness for classroom use. This study emphasises

ethnomathematics as an effective method to improve fraction understanding in teacher education.

Fisabilillah, A. et al. (2024) conducted a study on the ethnomathematics exploration of multiplying and measuring activities on the dome of the great mosque of Baitul Hakim, Madiun City. This research examines ethnomathematics in the architectural features of the Baitul Hakim Grand Mosque in Madiun, with an emphasis on its dome structure. Data were acquired using qualitative ethnography, involving observations, interviews with three mosque managers, and documentation. Findings indicate geometric principles such as isosceles triangles, trapezoids, ellipses, and pyramidal forms in the mosque's architecture, in addition to ethnomathematical methodologies like measurement and counting. The results illustrate how cultural artefacts may contextualise mathematics education, providing educators with concrete materials to connect abstract principles to practical applications. This study emphasises the mosque's capacity as a medium for ethnomathematics education, enhancing mathematical instruction via cultural associations.

Fuat, Rohibni, & Rayungsari, M. (2024) investigated the trends in temple ethnomathematics study and the development of the mathematical landscape. This study conducts a systematic review of ethnomathematics research from Indonesian Sinta-accredited journals, uncovering three principal findings: (1) insufficient practical links between mathematical and cultural concepts in temple studies, (2) redundant mathematical findings devoid of cultural specificity, and (3) inadequate utilisation of Indonesia's ecological diversity. The paper delineates substantial research deficiencies and advocates for the use of the Mathematical Landscape theory to investigate mathematical ideas within wider living settings. These findings establish a basis for enhancing culturally responsive mathematics instruction with international significance.

Guido David, G., et al. (2024) explore the impact of the PBL paradigm grounded in ethnomathematics on critical thinking abilities, assessed via the lens of patriotism in junior high schools. The objective is to examine the impact of the Problem-Based

Learning (PBL) paradigm, linked with ethnomathematics, on students' critical thinking abilities, while accounting for the mediating influence of curiosity.

Indriani, E., et al. (2024) conducted a study on the development of an ethnomathematics-based module to improve students' critical thinking skills. This research enhances understanding of the autonomous curriculum being established in Indonesia. Collaboration in ethnomathematics with an autonomous curriculum uncovers several aspects that affect the mathematics learning process. This research yields fresh insights into the outcomes of collaboration between autonomous curriculum and middle school ethnomathematics, while also proposing solutions to the encountered obstacles (validity index: 0.802) and reliable (rater agreement: 0.896). Essential strategies—cultural discovery, problem-based activities, and knowledge construction—augment student involvement and facilitate meaningful learning. The study identifies deficiencies in the application of ethnomathematics by engaging students in cultural-mathematical inquiry, providing a paradigm for culturally responsive mathematics teaching in the 21st century.

Istiqomah (2024) revealed in his study that an ethnomathematics technique was used to examine mathematical concepts in Banyuwangi's Osing traditional homes. The researchers employed document studies, content analysis, and semiotic techniques to analyze the architecture. They found geometric patterns in roofing, decorations, and buildings, supported by accurate measurements in room designs. Additionally, the construction process involved computations and numbers. These mathematical elements reflected the cultural values and beliefs of the Osing people. The study demonstrated how local knowledge is preserved through the integration of math and culture in traditional architecture. Through real-world examples, it emphasized the importance of ethnomathematics in learning cultural heritage and helping students connect with arithmetic.

Kiki Arion, K., & Neneng, N.T. (2024) stated that Ethnomathematics investigates mathematical principles within cultural frameworks, encompassing urban and rural communities, indigenous populations, and many vocations. This study investigates the enhancement of mathematical creative thinking skills using ethnomathematics-based

learning via a Systematic Literature Review (SLR) of fourteen papers sourced from Google Scholar, ResearchGate, and Springer Link. Research demonstrates that incorporating cultural values into mathematics education enhances motivation, engagement, conceptual comprehension, and problem-solving abilities, while safeguarding local knowledge. Ethnomathematics effectively cultivates creative thinking and cultural sensitivity, providing a significant methodology for mathematics teaching.

Kumala, F. Z., Agarica, F., & Gunawan, G. (2024) conducted a study to construct instructional games based on the Banyumas culture to help seventh-grade students better understand geometry. Using the ADDIE methodology, researchers developed an ethnomathematics learning material that received expert approval (83-93%). Field testing revealed a considerable improvement in the experimental class (N-Gain=0.73 vs control=0.43, $p<0.05$). The results revealed that the games significantly improved arithmetic comprehension through cultural context. The study proved how localised game-based learning connects abstract geometry with students' real-world experiences.

Miftahurrahmi, M. et al. (2024) in their study investigate ethnomathematics in Minangkabau Randai art, pinpointing mathematical components within its structure, spatial dimensions, and musical instruments. The investigation, employing qualitative descriptive methods and library research, demonstrates that Randai synthesises artistic, philosophical, cultural, and mathematical elements. The findings underscore how ethnomathematics enhances education by linking mathematics with cultural context, with Randai serving as a conduit for both tradition and mathematical principles.

Noprisa, et al. (2024) explore the Traditional House of Lampung Kedatun Keagungan: Ethnomathematics Exploration. The ethnomathematics of geometric ideas included in the Kedatun Keagungan traditional house's construction is examined in this paper. Students can better understand abstract topics through familiar visual representations when mathematics is connected to cultural themes. Data were gathered through focus groups, documentation, instrument validation, and observation using a qualitative ethnographic method. The Spradley model was used in the analysis. The construction

and ornamentation of the house incorporate geometric and transformational geometry ideas, according to the findings. These observations can guide the creation of meaningful and culturally appropriate geometry teaching resources.

Oktaviani, C. et al. (2024) in their study revealed that three Malay storybooks discovered connections between arithmetic and customs such as the Selaso Jatuh Kembar house (flat and angular shapes), the jalur weaving (measuring principles), and the galah panjang game (square/rectangular patterns). The narratives demonstrated how math was used in everyday activities, language, and attire. Children were able to see arithmetic as a part of their culture and daily lives because of this method. The results showed that stories with cultural significance could help young students find math more interesting and meaningful. The study demonstrated how this approach offers comprehensive mathematical insights.

Özcan, O & Bahadır, E (2024) investigated in their study of math teachers' and trainees' perspectives on the relationship between mathematics and culture. Researchers used open-ended questions to poll 34 teacher hopefuls and 32 working teachers. Cultural variety is widely regarded as beneficial to social and cognitive development in math education. Teachers and trainees both felt that it may improve the meaning and engagement of their learning. However, teachers were more concerned than trainees about classroom obstacles such as adaptation and communication. The survey revealed a lack of awareness, with fewer trainees comprehending intercultural relationships. These findings added to ethnomathematics research by demonstrating both potential benefits and real obstacles in culturally diverse math classes.

Putri, A. R., et al. (2024) conducted a study on the implementation of the Ethnomathematics-Based Student Worksheet “Surya Majapahit” on the Circle Elements Material to Build Creative Thinking of Elementary Students. The current research investigates the utilisation of an ethnomathematics-oriented student worksheet, using Surya Majapahit’s cultural legacy, to instruct on the constituents of circles in geometry. The study employed a qualitative descriptive methodology, including sixth-grade pupils from Lengkong II Public School in Mojokerto. The results

indicated that Surya Majapahit's geometric patterns facilitate learning, as evidenced by pupils attaining elevated scores (summative: 90; formative: 92.8) and enhanced creative thinking. The research emphasises the innovation of incorporating ethnomathematics into primary education, enhancing engagement, cultural appreciation, and creative problem-solving in mathematics.

Sari, S. A. et al. (2024) conducted a study that constructed an ethno-RME-based digital worksheet to help students enhance their mathematical relationships by exploring the cultural backdrop of Kudus Tower. Using the ADDIE methodology, researchers generated interactive web-based resources for 30 fifth-grade students in Central Java. Experts verified the worksheet's content (89% feasibility) and design (91% feasibility). Student assessments demonstrated great progress in connecting arithmetic principles to cultural factors. The findings revealed that culturally grounded digital tools improve mathematics understanding while maintaining local heritage.

Suherman & Vidákovich (2024) conducted research in which researchers have found that prior research has emphasised the need for creative thinking for mathematical performance; however, in ethnomathematics contexts, few studies have looked at the combined effects of parental education, ethnic identification, attitude, and creative style. A cross-sectional study of 896 secondary pupils found that positive math attitudes were substantially connected with fluency, flexibility, and originality in creative thinking, whereas ethnic identity increased flexibility. Surprisingly, creative style and parental education had unfavourable correlations to creativity at first, but turned positive as students progressed. The effect of parental education on creativity was also mediated by math attitude. These findings highlighted the intricate interaction of sociocultural and psychological elements in creating mathematical creativity, providing practical insights for culturally sensitive instruction

Sinaga, F. I. S. (2024) conducted a study on a hypothetical learning trajectory based on ethnomathematics. This research investigates how Ethnomathematics elucidates the relationship between mathematics and culture, investigating how human behavioural patterns in diverse situations influence mathematical comprehension. This method facilitates significant learning by connecting mathematical principles to cultural

situations. Educators can improve learning by using ethnomathematics-based Hypothetical Learning Trajectories (HLT), which organise lessons according to students' existing knowledge and cultural backgrounds. This study, employing literature review methods, concludes that HLT encompasses learning objectives, activities, and hypotheses, while incorporating culturally pertinent settings. Ethnomathematics-based HLT promotes contextual learning by tackling challenges, establishing material linkages, enhancing cognitive growth, and providing instructional assistance, thus enriching mathematics education.

Turmuzi, M., et al. (2024) analyse how meta-analysis evaluates the influence of ethnomathematics on students' mathematical communication abilities. Forest plot analysis and random effects models indicate that ethnomathematics greatly improves communication abilities relative to traditional techniques. Testing for heterogeneity and assessing publication bias validates the findings' robustness. The study illustrates the greater efficacy of ethnomathematics in enhancing mathematical communication, providing empirical support for culturally sensitive pedagogy in mathematics education.

Utami, N.R., & Irawati, R.K. (2024) researched the Effectiveness of Ethnomathematics-Based Learning Media on Students' Understanding of Geometry Material Concepts in Grade IV. This research investigates the discrepancy between students' mathematical experiences in school and outside of school, which frequently obstructs their understanding of geometric ideas. The researchers employed a quantitative experimental methodology to assess the comprehension of geometry between two primary classrooms at MI Al-Fitrah Tamiang Layang, Central Kalimantan: one utilising an ethnomathematics-based learning medium and the other adhering to conventional approaches. These findings support the implementation of culturally sensitive teaching techniques to connect abstract mathematical concepts with students' real-world experiences.

Wulandari, D. U., et al. (2024) researched the integration of Ethnomathematics Teaching Materials in Mathematics Learning in Elementary School. The purpose of this research is to provide the groundwork for future ethnomathematics studies, with a

focus on how to include ethnomathematics into mathematics curricula and how to create math learning objectives with an ethnomathematical flavour.

Yuliana Olga S Sabon, Y.O., & Telussa, R.P. (2024) explore in the article that the ethnomathematics-based learning paradigm, utilising Papua Mountain culture and following Dick and Carey's development model, comprises four stages: analysis, development, implementation, and assessment. The findings indicate that the learning model is both practical

Al-Jabar, S. Z. (2025) revealed a study using anthropological approaches to investigate mathematical notions in Bali's ayunan jantra (ceremonial swing) culture. Researchers witnessed the swing's construction and use in ceremonies while interviewing a local cultural expert. They recognised geometric characteristics (symmetry, proportion) in its structure and harmonic oscillation in its movement. The findings revealed how Balinese culture intuitively incorporates mathematics into its customs. The study stated that these ideas could improve ethnomathematics teaching by combining cultural preservation with math learning.

Orey, D. C., & Rosa, M. (2025) conducted a study to investigate ethno-modelling as a way to connect formal schooling with cultural mathematics. Scholars suggested integrating etic (outer) and emic (insider) knowledge to gain a deeper understanding of mathematical practices in cultural contexts. Through discussion and ethnographic techniques, the system emphasised intuitive, sympathetic learning. Results indicated that while maintaining cultural relevance, ethno-modelling aids in converting real-world issues into academic mathematics. Through the integration of several knowledge

Purwanto, W. R., et al. (2025) conducted a study on teachers' perceptions of ethnomathematics learning in the independent curriculum program in Indonesia. The present mixed-methods research investigates mathematics educators' opinions of ethnomathematics instruction within Indonesia's autonomous curriculum (2022/2023). The study integrated qualitative descriptions with quantitative analyses of 60 instructors from Kudus Regency, employing a trustworthy instrument (Cronbach's

α=0.826). The findings indicated diverse evaluations: 1.67% classified it as very good, 41.67% as good, 45% as sufficient, and 11.67% as fair. The findings demonstrate a generally modest acceptance of ethnomathematics integration among teachers. The research underscores the ramifications for educator training and curriculum design, proposing avenues to improve cultural-mathematical pedagogy. These observations can guide policy decisions about teacher empowerment and professional development initiatives to enhance curriculum implementation.

Rachman, K. et al. (2025) conducted a study to develop an Android app that teaches fourth graders ethnomathematics by using the culture of Tari Piring (Plate Dancing). Researchers developed an interactive learning tool using the 4-D R&D methodology (Define, Design, Develop, Disseminate). The software received a high feasibility rating from experts (96.25%) and a practical rating from students (93% acceptance). The app's ability to teach geometry with cultural context was demonstrated by the results. The study showed that ethnomathematics with technology enhances learning results and student engagement in elementary school mathematics instruction.

Solihin, A. et al. (2025) conducted a study in Surabaya, Indonesia, examining how Ethnomathematics and Zero Waste culture could enhance students' creative thinking and ecological awareness. Researchers employed Inquiry-Based Learning (IBL) and found that linking arithmetic to local waste management and recycling increased engagement in learning. Students showed improved problem-solving skills when applying mathematics to real-world sustainability challenges such as market spatial planning and data analysis. The approach improved both academic performance and environmentally conscious behaviour. However, the study focused only on Surabaya, suggesting that additional research should be carried out in different cultural contexts. The findings highlighted the importance of culturally relevant mathematics teaching for achieving sustainability.

2.3 An Overview of Reviewed Literature

The literature on ethnomathematics reveals a rich body of work that highlights the interplay between mathematics, culture, and education across different

communities worldwide. Early works such as those of Fasheh (1980) and Panda (2006) emphasised how mainstream mathematics education often fails to resonate with learners from indigenous or marginalised groups because it overlooks cultural knowledge systems. These studies set the stage for subsequent inquiries that demonstrated how deeply mathematics is embedded in cultural practices—from counting, measuring, and pattern recognition to architectural designs and traditional games. Research from different contexts (e.g., Kabihug tribe in the Philippines, Baduy culture in Indonesia, and Jambi wedding traditions) consistently shows that integrating cultural practices into formal mathematics instruction makes learning more meaningful and relevant, thereby enhancing engagement and performance.

Across many studies, a shared finding is that ethnomathematics improves motivation, comprehension, and problem-solving ability. For example, Rubio (2016), Septianawati et al. (2017), and Pramudita & Rosnawati (2019) illustrated how indigenous practices such as weaving, batik design, and everyday measurement systems can be translated into school mathematics. More recent studies like those by Az-Zahroh et al. (2019) and Richardo et al. (2023) demonstrated how combining ethnomathematics with technology (augmented reality, e-books, or educational apps) enriches learning, making abstract concepts more accessible while preserving cultural heritage. Similarly, problem-based learning (PBL) models and STEAM approaches grounded in ethnomathematics (e.g., Zaenuri et al., 2020; Hartini & Dafik, 2023; Guido David et al., 2024) reveal that students develop stronger creative and critical thinking abilities when culture is embedded in teaching strategies.

Despite these positive outcomes, several comparative insights emerge. First, there is a tension between preservation and adaptation. Studies such as Alangui (2020) caution against decontextualising or "colonising" cultural knowledge when integrating it into formal curricula. This contrasts with works like Prahmana (2019) or Pramudita & Rosnawati (2019), which show how cultural practices can be effectively adapted to modern classrooms. The implication is that ethnomathematics integration must strike a balance between authenticity and pedagogical practicality.

Second, there is a divergence in teacher readiness and perceptions. While some educators see ethnomathematics as a powerful pedagogical tool (Acharya et al., 2021; Purwanto et al., 2025), others report hesitancy, citing challenges in adaptation, communication, and curriculum demands (Özcan & Bahadır, 2024). This indicates that teacher professional development and curriculum design need stronger alignment with cultural mathematics approaches.

Third, there is unevenness in research coverage. Geometry, measurement, and patterns dominate the literature (Hendriyanto et al., 2023), while areas such as algebra, statistics, and higher-order mathematical reasoning remain underexplored in cultural contexts. Additionally, most studies focus on Asian and African communities, with fewer from Western or cross-cultural environments, despite increasing multicultural classrooms globally.

In terms of an overview, findings converge on the fact that ethnomathematics strengthens students' mathematical literacy, cultural appreciation, and cognitive growth. From traditional games like engklek in Indonesia to architectural explorations of temples, mosques, and houses across regions, studies highlight how everyday life provides authentic contexts for learning. Ethnomathematics also extends to character education (e.g., wayang puppet studies), ecological awareness (e.g., waste management in Surabaya), and digital innovation, underscoring its multidisciplinary potential.

The overall body of literature demonstrates that ethnomathematics serves not only as a pedagogical approach but also as a mechanism for cultural preservation. It bridges the gap between abstract mathematical concepts and real-world applications, ensuring learning is contextual, engaging, and socially relevant. However, several challenges remain. To advance ethnomathematics, a multi-faceted approach is essential. This requires strengthening teacher preparation to equip educators with the skills for authentic integration, while broadening research into underexplored mathematical domains and comparative international studies. Leveraging technology through tools like AR and gamified platforms can enhance scalability and engagement. Crucially, these efforts must be underpinned by cultural sensitivity, which can be

ensured through community participation to avoid misrepresentation. Ultimately, ethnomathematics should be strategically linked to wider educational objectives, framing it as a vital pathway for developing not only mathematical literacy but also creative thinking, sustainability, social identity, and intercultural understanding.

In sum, the literature indicates that ethnomathematics is not merely an alternative approach but a necessary dimension of equitable and meaningful mathematics education. The challenge ahead lies in expanding its reach, deepening its authenticity, and embedding it within policies and practices that prepare students for both local realities and global competencies.

2.4 Research Gap

The reviewed literature clearly establishes that ethnomathematics serves as a meaningful bridge between mathematical concepts and learners' cultural experiences, enhancing comprehension, creativity, and engagement. Numerous studies have explored ethnomathematical practices among various indigenous groups such as the Baduy, Kabihug, Sasak, and Tangkhul tribes, revealing how counting, measuring, patterning, and spatial reasoning are embedded in daily life, architecture, art, and rituals. However, most of these studies are concentrated in regions such as Indonesia, the Philippines, and Africa, with limited attention to tribal communities in Northeast India. Although Indian scholars like Panda (2006) and Singh et al. (2019) have discussed the general challenges of mathematics learning among tribal learners, there remains a significant gap in documenting, interpreting, and integrating the mathematical practices of the Mizo tribe within formal education.

The literature highlights methodological limitations—many studies describe cultural artefacts but seldom connect them to cognitive learning processes or pedagogical frameworks. There is a lack of systematic investigation into how ethnomathematical knowledge can be aligned with contemporary curricula to improve learning outcomes among indigenous learners. No comprehensive ethnomathematical study has yet examined the Mizo people's traditional practices, numeration systems, spatial designs, and problem-solving methods in relation to mathematics education.

Addressing this gap will contribute not only to preserving local knowledge but also to developing culturally responsive mathematics instruction that fosters meaningful learning, equity, and inclusion among Mizo students.

2.5 Conclusion

A literature review integrates and synthesises essential materials, hypotheses, facts, and scholarly discussions as the preliminary phase of any research endeavour. It links prior research and proposes future studies to support the present study. The researcher can establish a coherent theoretical and conceptual framework by meticulously reviewing books, peer-reviewed journal articles, reports, conference proceedings, dissertations, and other credible sources. Academic literature reviews evaluate, contrast, and integrate knowledge to determine relevance, validity, and applicability. Through critical thinking, researchers can avert redundancy, enhance prior research, and delineate the study's role within academic discourse. A thorough literature study demonstrates the researcher's expertise on the issue and capacity to identify trends, paradoxes, and patterns. The study's scope is defined by identifying what has been researched and where additional insights may be obtained. Evaluating the merits and limitations of previous studies enhances research concepts, hypotheses, and methodologies.

Based on the above literature review, the researcher has obtained deeper issues in terms of culturally responsive mathematics learning, and substantial evidence regarding challenges in mathematics achievement, as well as its roots in the cultural aspects of society. Therefore, after studying the existing knowledge reserve, the need for integration of various components of culture in the modern classroom teaching was felt, which has led the researcher to conceptualize the present research problem.

Chapter-III

Research Design and Procedures

3.1 Design of the Study

This study employed a two-phase, i.e., exploratory (QUAL–QUAN) research methodology to empirically examine the research question.

Phase-I

In the first phase of the study, an **exploratory survey** was conducted to identify the elements of mathematics and its various aspects within the culture of the Mizo tribes. This phase included the interview of some of the identified indigenous Mizo people and educated professionals in research and teaching. Along with this, an interview schedule was used to observe the same.

Phase-II

The second phase of this study was to test the effectiveness of ethnomathematical teaching strategies/lesson plans on mathematics achievement for class VIII students by employing an experimental study. The experiment was carried out in naturally set classroom environments. This study used a Non-Equivalent Pre-test – Post-test Quasi-Experimental Design. Initially, a pre-test was conducted on both groups (control and experimental) to collect initial data for subsequent comparison and alignment of the two groups. The adopted tests were used to assess the preliminary state of both groups. After completing the pretest, the experimental group received instruction using ethnomathematical teaching strategies, applying the developed ethnomathematical lesson plan. The control group, in contrast, was instructed using traditional teaching methods. The experiment lasted for 31 working days, with each period lasting 45 minutes in both classrooms.

Table 3.1: Quasi-Experimental Design

Groups	Pre-Test		Treatment	Post-Test
A	O1	→	C	O2
B	O3	→	X	O4

Where: A= Control Group, B= Experimental group, C= Conventional Method of Teaching, X= Ethnomathematical Lesson plan-based teaching strategies Approach, O1& O3= Pre-test, and O2 & O4= Post-test.

3.2 Population and Sample of the Study

The study's population and sample were delineated as follows:

Population

Phase-I

The indigenous people of the Mizo Tribe of Mizoram, who are involved in their traditional activities (*like making a square base small basket, bamboo stool, winnowing tray, crab trap, and Mizo bow*) and educated Mizo professionals, especially in research and teaching from Mizoram, were the population for the first phase of the study.

Phase-II

The research population comprised class VIII students enrolled in the Mizoram Board of School Education (MBSE) in Aizawl City for the academic year 2024-2025.

Sample

Phase-I

For the first phase, five (5) indigenous groups of 7 to 8 people (involved in their traditional activities) from each District of Mizoram and educated Mizo professionals in research and teaching from Mizoram University were selected using a purposive sampling technique. Also, the researcher visited the Mizoram State Museum to clarify the English names of the indigenous materials.

Phase-II

For the second phase, the researcher has taken a School, namely Helen Lowry School, which is very convenient to the researcher and where two sections (control and experimental) are available to experiment. Since the prepared lesson plan is based on the dimensions of ethnomathematics, and to minimize the interaction effect during the experiment, two different sections (A and B) from the same school, which have the same learning environment and standards, have been selected.

The study sample comprised 90 students from sections A and B of Class VIII of the academic year 2024-2025. The school prohibited the random assignment of students into groups. Thus, the researcher was compelled to experiment on an intact group present in the schools.

Table 3.2

Distribution of the Sample

School	Section	Group	N
Helen Lowry School	A	Control	45
	B	Experimental	45

3.3 Variables of the study

This study encompassed two variables. The instructional approach (i.e., ethnomathematical teaching strategies and conventional approaches) served as an independent variable. Whereas, Mathematics achievement among Class VIII students was the dependent variable.

3.4 Instruments / Tools used in the study

The extent of generalisation and authenticity of any research study is essentially contingent upon the use of legitimate and reliable data collection instruments. Consequently, to assess the independent and dependent variables of the study, the investigator developed a data collection tool and an Ethnomathematical lesson plan, while also adopting a standardized tool. The following tools are used in this study

1. **Interview Schedule for indigenous Mizo people and Mizo professionals**
2. **Ethnomathematical Lesson Plan for Class VIII students**
3. **Test of Mathematics Achievement for Class VIII students**
4. **Semi-Structure Interview Schedule for Class VIII students**
5. **Mixed-Type Group Test of Intelligence for Class VIII students**

1. Interview Schedule

The study indicated that to observe and identify the traditional activities and cultural practices of the Mizo community, it is essential to conduct interviews with community members, whether unstructured or semi-structured. The interview and systematic observation (both participant and non-participant) may regulate the researcher in any divergence from the research objectives. The review revealed a lack of established criteria for conducting unstructured interviews to gather evidence from any community. Many scholars have utilized various needs-based developmental tools in their interview schedules. In this section of the study, the researcher aims to examine the mathematical elements present within the Mizo tribe and to find various mathematical activities embedded within the tribe's culture. To accomplish this, the investigator opted to create an unstructured interview schedule for a comprehensive examination of the cognitive processes, practices, activities, and mathematical or logical reasoning employed by the Mizo cultural group.

To develop this interview schedule, the researcher has followed the steps below. The researcher developed the initial draft of the interview schedule with the help of the supervisor and submitted to experts in the field for correction. After getting responses from the experts, some items were deleted, and some were included.

Specifying the areas/themes of the Interview

The main goal of the interview was to identify the traditional activities of the Mizo community. The researcher has focused on two primary domains of the Mizo people: Biographic Information and Cultural materials. The interview effectiveness may be perceived as structured; however, during the investigation, greater flexibility

was required for the Mizo community in discussing their cultural practices and other information, making it unstructured.

- **Choosing the Questions and Interview Format**

The interview format was unstructured, and the questions were open-ended. The comprehensive interview schedule has two structural perspectives. The interview commenced with enquiries regarding biographical information, followed by a main part that focused on traditional activities, mathematics, cultures, and related topics. All questions and statements were formulated in Mizo and English and delivered at their convenience. The investigator formulated the questions with assistance from distinguished researchers in the subject.

The interview schedule questions were framed considering the following classification:

Table-3.3:

Classification of Questions

Sl. No.	Classification	Question No.
1	Bamboo basket	Q-1
2	Trap	Q-2
3	Clay	Q-3
4	Mithun horn	Q-4
5	Typical Mizo house	Q-5
6	Music	Q-6
7	Wood	Q-7
8	Household	Q-8
9	Gallon/Container	Q-9
10	Hand-woven Fabric	Q-10
11	Jhum cultivation tools	Q-11
12	Other Cultural Materials	Q-12

- **Reliability, validity, and fairness of the interview**

The researcher had to cope with the intricacies of analysing interview properties. The researcher was focused on inter-rater reliability, assessing if various interviewers or scholars provide consistent ratings while evaluating the same topic or seeing the same performance within the Mizo community, and deemed it appropriate.

Ensuring the reliability of the interview schedule proved difficult due to the uniqueness of each interview technique and the unstructured nature of the interviews. Reliability was inconsistent due to discrepancies among interviewers on the questions posed and the responses provided by the Mizo people. To ensure reliability, comprehensive one-on-one interviews were conducted with the individual, using exclusively open-ended questions.

The tool's validity was established during the construction phase. The scholars' comments in this field were considered to establish validity, specifically regarding whether the interview questions effectively assessed the traditional activities and lifestyles of the Mizo community, and whether there was a one-to-one correspondence between the investigated areas and the characteristics of the individuals.

The primary concern regarding the interview schedule was the researcher's impartiality during the interview process. Secondly, fairness was achieved through the utilization of unstructured and open-ended questions that incorporated familiar language from the Mizo community. Thirdly, fairness was ensured by formulating the questions in both Mizo and English, allowing respondents to answer at their own convenience. There were no time constraints for responding to the questions, which constituted the fourth aspect of fairness. In addition to this, direct interaction involves facial expressions and feelings while performing tasks and articulating methods without hesitation.

2. Ethnomathematical Lesson Plan

Preparation of an Ethnomathematical lesson plan is done in the following stages

1. Identification of the content and topic

2. Identification of Mizo cultural aspects
3. Materials used in the Mizo day-to-day life
4. Preparation of components of the lesson plans with pedagogical aspects
5. Development of ethnomathematical lesson plans
6. Validation of ethnomathematical lesson plans
7. Pilot testing of ethnomathematical lesson plans
8. Development of final ethnomathematical lesson plans

Ethnomathematical lesson plans were classified as under

Table: 3.4
Classification of Lesson Plan

Textbook Chapter	Contents	No. of Lesson Plans Developed
3	Understanding Quadrilaterals	Three (3)
4	Practical Geometry	Two (2)
5	Data Handling	Two (2)
10	Visualising Solid Shapes	Two (2)
11	Mensuration	Three (3)
15	Introduction to Graphs	Two (2)
Total		**Fourteen (14)**

3. Test of Mathematics Achievement

Need of the test

This study aimed to evaluate the effectiveness of ethnomathematical teaching strategies on the mathematics achievement of Class VIII students, for which the investigator developed the Test of Mathematics Achievement (TMA). When

reviewing the available tools, it was determined that numerous mathematical achievement tests exist for various grade levels; however, the material and dimensions addressed by those tests are unsuitable for the current study. Therefore, the researcher has recognised the necessity to develop a tool to evaluate the mathematics achievement of eighth-grade students.

Hence, all the tools were found inappropriate for the requirements of the study. Therefore, the researcher decided to develop a tool for mathematics achievement as per the requirements of the current study.

Development of Test of Mathematics Achievement (TMA)

The development of the mathematics achievement test comprised three distinct stages, as outlined above.

(I) Exploratory Stage.

(II) The Development stage.

(III) Final stage.

(I) Exploratory Stage

The initial phase involved the exploration of tool development. At this stage, the investigator developed items after determining the main topic to be assessed for algebraic achievement. At this point, the investigator examined the textbooks of the Mizoram Board to identify and select the content.

A. Selection of content for the test of mathematics achievement

To determine the subject for mathematical achievement, the researcher examined the Mizoram board syllabus. After reviewing the curriculum and the textbook, the researcher identified the chapters and their respective content.

Table 3.5

Selected Content

Textbook Chapter	Contents	Pages
3	Understanding Quadrilaterals	37-56
4	Practical Geometry	57-68
5	Data Handling	69-88
10	Visualising Solid Shapes	153-168
11	Mensuration	169-192
15	Introduction to Graphs	231-248

B. Preparation of the items

The primary objective of the mathematics achievement test is to assess the mathematical performance of eighth-grade students. The students' achievement is influenced by the lesson plan and teaching practices; therefore, measures were implemented to ensure that the items are designed to cover the topic selected for the lesson plan development.

The subsequent action was implemented in this context. Items were directly associated with the topic and aligned with the objectives of each unit in the lesson plan. Items were specifically constructed in accordance with Bloom's taxonomy. All items were structured as multiple-choice questions, each presenting four distinct responses, of which one was correct.

Thus, 35 items for the mathematics achievement test were prepared. The 35 items covered all the content from the mentioned chapters of the textbooks.

C. Pre try-out

The initial draft of the Test of Mathematics Achievement (TMA) was carried out with a sample of 50 pupils in class VIII. The purpose of conducting the TMA was

to examine the suitability of item difficulty, linguistic clarity, content adequacy, item design, statement simplicity, and learner accessibility.

After the administration of the TMA, the difficulties encountered by the students were documented to enhance the final draft. The pre-trial made it evident that the respondent provided instructions and clearly comprehended the language of the items. The perspectives of subject teachers about each item were also taken into account. The number of items retained from the first drafts in the second draft is presented below in the table.

Table: 3.6

Retained item from first draft

S.No.	Contents	No of items	Serial no of items in the tool
1	Understanding Quadrilaterals	**6**	**1,2,3,5,16,23**
2	Practical Geometry	**6**	**9,11,17,25,27,29**
3	Data Handling	**5**	**4,6,13,21,32**
4	Visualising Solid Shapes	**6**	**12,14,18,22,24,28**
5	Mensuration	**6**	**8,20,31,33,34,35**
6	Introduction to Graphs	**6**	**7,10,15,19,26,30**

D Scoring

A scoring key was developed with the help of a mathematics teacher (PGT) by solving each question and determining the right answers, which the investigator later verified. Scoring was carried out carefully, assigning '1' for correct answers and '0' for incorrect answers.

E Second Draft of the Test

All items from the initial draft of the mathematics achievement test were retained in the second draft, with slight modifications to the language of those items considered unclear or difficult during the pre-try-out phase. The second draft of the tool comprised the following components:

- **Instructions of Administration**

An introductory statement was provided to articulate the objective and significance of the study, along with essential instructions for completing the test.

- **The Title of the Test**

The test was designed to assess mathematical achievement based on its content. A suitable title for the test was selected: "Test of Mathematics Achievement (TMA)."

(II) The Development stage

A. Try-out

The test was administered to 100 students in person. The test instructions were read after they had been distributed. Examples were employed to illustrate the marking procedures. It was highlighted that no item should be omitted during the administration of TMA, and the respondents were requested and encouraged to provide an authentic response to each item.

B. Item analysis

Item analysis is a crucial step in the standardisation of any tool. Item analysis is a statistical method employed to choose or reject test items based on their discriminatory efficacy. Following pilot testing, the test underwent item analysis to identify which items were easy or difficult, as well as those that were malfunctioning (Stanley et al., 1978). Besides relevance, a commonly sought attribute for a test item is discrimination analysis. To obtain suitable items via item analysis, the researcher utilised 100 answer sheets from the selected sample. The individual's scores for all 100 samples were determined and organised from highest to lowest. The scientists subsequently selected the top 27% of the sample, comprising the high scorers, and the bottom 27%, consisting of the low scorers.

C. Item Selections

Difficulty Index of an Item

The difficulty index of an item is shown by the percentage of students who answered it correctly. The formula is given below.

D.I. = U + L/2N

Where, U is the number of correct answers in the upper group

L is the number of correct answers in the lower group

N is the number of students in both groups.

Discrimination Power of an Item

The discriminating power of an item measures its ability to differentiate betw een individuals who perform well on the overall test and those who do not. It disting uishes between those possessing the measured attribute and those lacking it. In this p articular situation, the characteristic is " mathematics achievement. The item's discri minative power was computed using the formula.

D.P. = U – L/N

Where, U is the number of correct answers in the upper group

L is the number of correct answers in the lower group

N is the number of students in both groups.

Selection of Items

From the above-mentioned reasons and formulas, the difficulty index and discrimination power of each TMA item were calculated. Any item with a discriminating power over 0.30 should be regarded as a sufficiently effective item (Ebel, 1966). In this experiment, only items with difficulty indices between 0.25 and 0.75 and a discriminating power over 0.40 were selected. Table 3.8 lists the specifics of this exercise.

Table: 3.7

Table showing the 'D.I.' and 'D.P. Values obtained from Item analysis and selected items for the test of mathematics achievement

Item	D.I.	A/R (0.25-0.75)	D.P.	A/R (0.40 and above)	Result
Item no. 1	0.26	**A**	0.44	**A**	**A**
Item no. 2	0.65	**A**	0.41	**A**	**A**
Item no. 3	0.44	**A**	0.52	**A**	**A**
Item no. 4	0.54	**A**	0.41	**A**	**A**
Item no. 5	0.46	**A**	0.48	**A**	**A**
Item no. 6	0.78	**R**	0.07	**R**	**R**
Item no. 7	0.46	**A**	0.41	**A**	**A**
Item no. 8	0.54	**A**	0.48	**A**	**A**
Item no. 9	0.44	**A**	0.59	**A**	**A**
Item no. 10	0.56	**A**	0.44	**A**	**A**
Item no. 11	0.91	**R**	-0.11	**R**	**R**
Item no. 12	0.26	**A**	0.52	**A**	**A**
Item no. 13	0.52	**A**	0.44	**A**	**A**
Item no. 14	0.61	**A**	0.41	**A**	**A**
Item no. 15	0.35	**A**	0.41	**R**	**A**
Item no. 16	0.59	**A**	0.59	**A**	**A**
Item no. 17	0.96	**R**	-0.07	**R**	**R**
Item no. 18	0.48	**A**	0.52	**A**	**A**
Item no. 19	0.46	**A**	0.41	**A**	**A**
Item no. 20	0.61	**A**	0.41	**A**	**A**
Item no. 21	0.93	**R**	0.15	**R**	**R**
Item no. 22	0.69	**A**	0.41	**A**	**A**
Item no. 23	0.52	**A**	0.44	**A**	**A**
Item no. 24	0.61	**A**	0.41	**A**	**A**
Item no. 25	0.50	**A**	0.41	**A**	**A**
Item no. 26	0.54	**A**	0.41	**A**	**A**
Item no. 27	0.59	**A**	0.44	**A**	**A**
Item no. 28	0.31	**A**	0.48	**A**	**A**
Item no. 29	0.48	**A**	0.59	**A**	**A**
Item no. 30	0.50	**A**	0.41	**A**	**A**
Item no. 31	0.57	**A**	0.41	**A**	**A**
Item no. 32	0.80	**R**	0.26	**R**	**R**
Item no. 33	0.65	**A**	0.41	**A**	**A**
Item no. 34	0.61	**A**	0.48	**A**	**A**
Item no. 35	0.50	**A**	0.41	**A**	**A**

Note: A- denotes the items accepted; R- denotes the items not selected/rejected.

The table indicates that precisely 30 items were selected and retained for the final test. Therefore, after the item was analysed, a total of 5 items were removed from the test, resulting in a final draft of the TMA comprising 30 items.

(III) Final Stage

A. Time limit

During the exploratory phase, respondents were allocated 40 minutes. During the administration of the second draft, it was observed that the majority of respondents completed the questions within 30 minutes. Consequently, a duration of 35 minutes was designated for the last stage of the test.

- **Final draft of the test**

The final format of the mathematics achievement test comprises 30 multiple-choice questions. One mark is awarded for each correct answer and zero marks for each incorrect response. The test has a maximum score of 30 and a minimum score of 0.

B. Reliability of the Test of Mathematics Achievement

Kerlinger (1973) defined a trustworthy measuring instrument as one that is essentially free of measurement mistakes, hence ensuring both accuracy and predictability. The accuracy of the measuring device pertains to the degree of internal consistency of the test, namely the uniformity of results acquired within a single administration, or, in other words, the precision with which the test measures at that specific moment (Freeman, 1965). The reliability of TAA in the current investigation was determined using the split-half method and the KR-20 method.

(a) Split-half method

The most expedient approach to ascertain reliability is to divide a test into two halves (Tuckman, 1978), typically the odd-numbered and even-numbered items, and subsequently correlate the results achieved by each individual on both halves. This

approach, which produces an estimate known as 'split-half' reliability, allows an investigator to ascertain whether the two halves of a test are measuring the same quality or characteristic. In this study, the scores of 100 students on the final examination were divided into two parts. During the division into halves, it was assured that each half contained an equal number of items for every individual value, and the coefficient of split-half dependability was calculated. The outcomes are displayed below in Table 3.9

Table 3.8: Split-half Method

Measuring tool	Reliability coefficient
Test Mathematics Achievement	0.78

(b) K-R 20 method

Given that all items of TMA are homogeneous and each item is scored as either 1 or 0, the Kuder-Richardson 20 (K-R 20) was used, yielding a value of 0.79.

Table 3.9: K-R 20 Method

Measuring tool	Reliability coefficient
Test Mathematics Achievement	0.79

The TMA was determined to be a reliable instrument for assessing the mathematics achievement of class VIII students.

C. Validity of Test of Mathematics Achievement

Reliability denotes the precision of a measurement, while validity addresses whether a measurement accurately assesses what it purports to measure. Kerlinger (1973) identified content and construct validity as the most significant among the three categories of validity, since they relate to the extent to which specific explanatory constructs may account for respondents' performance on a particular measure. Consequently, to ascertain the validity of the TMA, both content and construct validity were established.

(a) Content validity

Content validity is a primary indicator that enables us to assert the purpose of the test's content, specifically what the test assesses. The extent to which a test's content accurately reflects the domain it is intended to assess. Content validity fundamentally relies on the assessment of experts within the discipline. The content validity of the test of mathematics achievement was determined based on the judgments and feedback of specialists in education, mathematics, and mathematics education. The primary objective of an achievement test is to assess the extent of content acquired by the students. So, according to Best & Kahn (2006), content validity is deemed optimal for these categories of tests. Experts from each discipline were selected to validate the test. All items were evaluated by experts from various fields, who assessed their content relevance and deemed them appropriate. Additionally, the relevance of the items was tested during the initial trial.

Therefore, the 'Test of Mathematics Achievement' might be considered to have sufficient content validity.

(b) Construct validity

The construct validity of the mathematics achievement test was determined using Cronbach's alpha, which serves as a measure of internal consistency and factor concentration of the test (Cronbach, 1951). The Cronbach alpha coefficients for all items exceeded 0.75. This indicates that the mathematical achievement test possesses construct validity.

4. Semi-Structured Interview Schedule for Class VIII students

The semi-structured interview schedule has 10 open-ended questions, all of which highlight the key components of teaching strategies of the lesson plans, including activities, assessments, and experiences associated with learning mathematics through an ethnomathematical lesson plan. After concluding the experiment, a semi-structured interview schedule was employed to gather the mathematics learning experiences of the experimental group students. The questions in the semi-structured interview schedule have been categorized into four distinct

groups relating to the learning associated with the teaching strategies outlined in the lesson plans. The categories of questions are as follows

Table 3.10: Experiences of Students

Sl. No.	Type of Experiences	Question Number
1	Experiences related to comprehensive learning through the lesson plan	**Q1, Q5, Q8**
2	Experiences related to the lesson plan activities.	**Q2, Q4**
3	Experiences related to the acquisition of mathematical knowledge with the help of the lesson plan	**Q6, Q7, Q10**
4	Experiences associated with learning through textbooks and the distinctions perceived when utilising the lesson plan	**Q3, Q9**

After developing the initial draft of the semi-structured interview schedule, it was presented to subject-matter experts in the field of education for validation. Finally, after assimilating the recommendations concerning the phrasing and aims of the questions, the expert's final draft was completed.

5 Mixed-Type Group Test of Intelligence for Class VIII students

The present test was developed by Dr. P.N. Mehrotra. The test consisted of two components: verbal and non-verbal tests. Each test comprises fifty items arranged in an omnibus selected format, and this particular assessment is aptly designated as the mixed test of intelligence. This was utilised to assess the IQ of students aged 12 to 17 years. Consequently, the assessment was deemed appropriate for Class VIII students. The test's reliability has been evaluated using three methodologies. The reliability coefficients derived from these methods are shown as follows:

Table 3.11

Reliability Coefficients of Mixed-Type Group Test of Intelligence

Methods of Reliability	Verbal test	Non-verbal test	Full test
Split half	0.91	0.81	0.88
Test – retest	0.89	0.82	0.86
Kuder Richardson	0.90	0.80	0.85

The test's validity has been established by the five specified criteria

1. Correlation with educators' ratings.
2. Correlation with assessment scores.
3. Correlation with other test scores.
4. validity of all sub-tests concerning 'g' saturation.
5. Validity of Factorial Structure.

3.5 Data Collection

Throughout the research data collection process, the investigator worked to obtain authentic data.

Phase-I

The first phase of the data collection process was classified into two categories. Firstly, the researcher collected data from different districts of Mizoram by visiting Mizo people who are illiterate and gathered information through interviews. The researcher gives the instructions in their local language for better understanding, and after making them feel comfortable, the researcher proceeds by following the interview schedule. Also, the researcher went to the Museum to clarify the English names of indigenous materials and took the pictures.

Secondly, the researcher also collected data from highly educated individuals, such as professionals, particularly those in research and teaching.

Phase-II

Due to the nature and requirements of the research, both control and experimental groups were necessary for the experiment. For this purpose, the

investigator identified five distinct schools. Several schools experienced a shortage of students, and upon selecting a school with two sections, the investigator requested the principal's approval for the experiment. After obtaining the school's official consent, a formal letter from the Department of Education, Mizoram University, detailing the study's title, the nature of the experiment, and the research's objective, was sent to the principal.

Before experimentation, a pilot study was conducted to standardise the test, i.e., Test of Mathematics Achievement (TMA).

For the pilot project, Mount Carmel School in Aizawl was chosen, and 100 students were selected to participate. A standardization test was conducted to collect data.

The preliminary data was gathered in April 2024, during which the tools were modified and developed. The final data collection occurred from May to July 2024. The experiment was conducted in an actual classroom environment, using a standard mathematics class in the school. In the second phase of the investigation, four distinct tests were employed to collect data.

1. Intelligence test by P.N. Mehrotra.
2. Ethnomathematics Lesson Plans.
3. Test of Mathematics Achievement (TMA).
4. Semi-Structured Interview Schedule.

The four tests were administered to the selection for pre-testing, wherein the experimental group was instructed using Ethnomathematical teaching strategies, while the control group received traditional instruction. The experiment was conducted in a real classroom environment, utilising a standard mathematical class in the school. The experiment was carried out in 31 working days/62 periods, with each group allocated periods of 45 minutes.

3.6 Data Organisation

Once the pre- and post-tests were finished, the collected data were organised appropriately. Following a precise evaluation of all tests, findings were recorded on

the master sheet after each test sheet was correctly coded. Excel served as the master sheet for all experimental data, and the SPSS software was used to analyse the scores to derive meaningful conclusions.

3.7 Techniques of Data Analysis

This study primarily employed a qualitative research method, using a naturalistic method along with an ethnographic approach. This study used the Miles & Huberman (1994) paradigm of qualitative data analysis to derive inferences from the acquired information, thus fulfilling the first phase of objectives. The collected data from observation and interviews were analysed in three stages, as illustrated in Figure 3.1. The initial phase, namely data reduction, involved the simplification, abstraction, and transformation of the data collected from the field notes/report. The objective was not just to manage the data but also to facilitate its transformation, enabling the information to be comprehensible regarding the issues under investigation. The second step was matrix display and examination, used to give a structured and compact compilation of data that permits inference and verification. All information obtained from the interview was effectively presented and systematically organised to fulfil this step. The final step was to formulate a unified statement regarding the presented data and assess its implications.

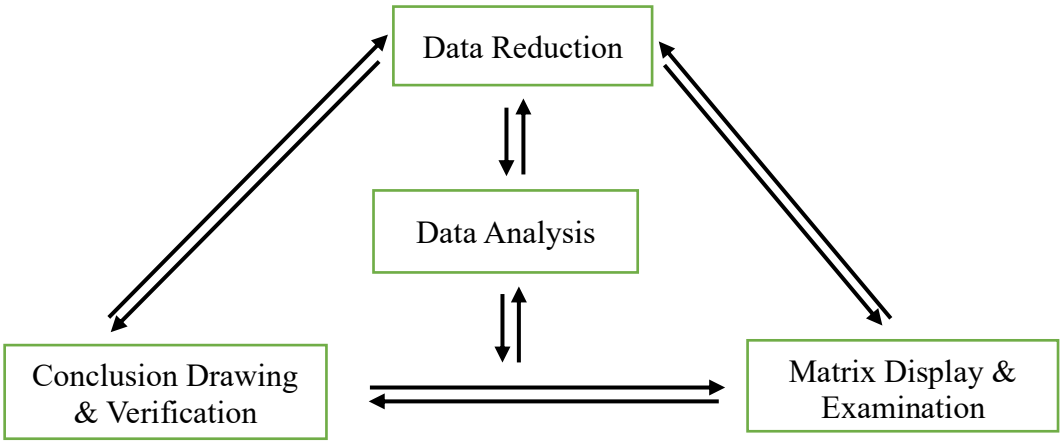

Fig 3.1: Data Analysis Cycle

3.8 Statistical Technique Used in the Study

The total scores from all tests were carefully maintained in separate excel sheets, as the research employed an experimental methodology. After the experiment was completed, the data collected were analysed using appropriate statistical methods, including Mean, Median, Standard Deviation, etc., and Levene's Test of Equality of Error Variance, along with F-test and Analysis of Covariance, as per the requirement of the study objective to evaluate various hypotheses and draw conclusions.

All statistical calculations were conducted using version 27 of the SPSS software package and Microsoft Excel.

Chapter-IV

Analysis and Interpretation of Data

4.1 Introduction

This chapter provides an in-depth analysis and explanation of the data. The primary focus of the study is to study and identify the mathematical elements that exist in the culture of the Mizo tribe and connotate the cultural materials with Class VIII standards through an ethnomathematical lesson plan and to examine the effect of ethnomathematical teaching strategies on mathematical achievement. A quasi-experimental pretest-post-test non-equivalent control group design was employed for this purpose, as previously stated in the preceding chapter.

To evaluate the effectiveness of ethnomathematical teaching strategies on mathematical achievement, the researcher selected a school with two sections for control and experimental groups. This chapter discusses and presents findings related to all study objectives. For drawing significant conclusions, various statistical techniques such as Mean, Standard Deviation, Levene's test for equality of error variance, ANOVA, and ANCOVA have been used to obtain the results. Also, the researcher has gathered qualitative data comprising students' perspectives and feedback on the ethnomathematical teaching strategies. The qualitative data were analysed, and the findings related to this were provided in the current chapter. Before experimenting, the researcher used a tool to assess the intelligence levels of students in both the control and experimental groups.

4.2. Findings related to Objective 1:

Objective 1: To study the mathematical elements which exist in the culture of the Mizo tribe.

Mathematics is universally recognized as a human activity that extends far beyond formal education, intricately intertwined with cultural practices, traditions, and lifestyles. All communities, whether indigenous or contemporary, reflect mathematical reasoning in their daily practices, material culture, and social structures. The Mizo tribe in Northeast India displays the integration of mathematical concepts within cultural expressions, traditional activities, and indigenous knowledge systems. These cultural expressions demonstrate that mathematics is not culturally neutral; rather, it is influenced by and reflects the beliefs, needs, and environment of a community (Bishop, 1988; D'Ambrosio, 2001). The products, artefacts, and activities constituting Mizo heritage exhibit inherent mathematical components, highlighting the relationship between form, function, and measurement.

Traditional crafts and weaving demonstrate an understanding of geometry, symmetry, and proportion through patterns, repetitions, and balance. Agricultural methods exemplify the application of mathematics in land measurement, spatial distribution, and seasonal cycles, while the design of equipment and utensils reflects an understanding of dimensions, volume, and resource optimisation (Gerdes, 1996; Zaslavsky, 1994). Musical instruments and cultural performances exemplify rhythm, sequencing, and ratios, which can be analysed as mathematical constructs within an artistic framework (Ascher, 1991). Architectural practices and construction clearly demonstrate the principles of measurement, stability, and proportionate reasoning, indicating that mathematical reasoning is fundamental to both functioning and beauty within the community.

The ethnomathematical perspective highlights that cultural practices serve as significant mathematical resources, offering genuine contexts that connect indigenous knowledge with formal education (Rosa & Orey, 2016). For learners, especially within the Mizo setting, integrating mathematics with recognisable cultural components enhances accessibility, engagement, and relevance to daily life, therefore promoting a deeper comprehension and appreciation of both mathematics and culture (Supiyati & Halqi, 2020). In addition, cataloguing these cultural artefacts and practices aids in the preservation of indigenous knowledge and enhances worldwide comprehension of va

ried mathematical traditions. This highlights the idea that mathematics is not a monolithic construct but a dynamic field enriched by the contributions of different societies across time and space.

Thus, exploring the cultural artefacts of the Mizo tribe provides insight into the integration of mathematical concepts within everyday life. The subsequent table displays a collection of cultural artefacts that embody mathematical components, showing the richness and variety of mathematical understanding throughout Mizo culture.

Table: 4.1

Mathematical elements which exist in the culture of the Mizo tribe.

Sl. No.	Indigenous Name	English Name (Mizo)
1.	Aiawt	Crab trap
2.	Arbawm	Chicken basket
3.	Baibel	Earthen pot
4.	Belval	Belval
5.	Berhbu	Brass bowl
6.	Buhherkhawl	Wooden mortar
7.	Buhtlei	Rice stirrer
8.	Chaicheh	Tongue /nipper/pincer
9.	Chawthlwngpui	Mizo plate/standard wooden plate
10.	Chempui	Dao
11.	Chhemthei	Chhemthei
12.	Chhihri	Sieve
13.	Chingal Thlawrbel	Leaching funnel
14.	Darkhuang	Musical drum
15.	Darngun kual	Spiral brass bangles
16.	Dawrawn	Dawrawn
17.	Fairel bel	Earthen vessel/clean rice vessel
18.	Favah	sickle
19.	Fenthlir	Ladle/dipper

20.	Fungki	Gun powder container
21.	Hachhek	Adze
22.	Herhsawp	Mizo stool
23.	Hmui	A spinning wheel
24.	Hnam	Basket strap
25.	Hnawhtawt	A trap for killing rat
26.	Hreipui	Axe
27.	Ipte pui	Mizo traditional bag
28.	Kahpuk	Bamboo toy gun
29.	Kaihbu	Lattu
30.	Kalchhet	Stilt
31.	Kho/fawng	Square base small basket
32.	Khuangpui	A common large drum
33.	Khuhhriang	Traditional bowl
34.	Khumbeu	Mizo cap
35.	Lensuah	Lensuah
36.	Lunglehkha	Slate
37.	Mau haileng no	Ordinary bamboo cup
38.	Maufian	Bamboo spoon
39.	Mizo in	Typical Mizo house
40.	Ngaawt	Fish basket
41.	Nghawngkawl	Yoke
42.	Ngotekherh	Ngotekherh
43.	Pai Em/ Emping	Closed-weave carrying basket
44.	Paikawng	Open-weave carrying basket
45.	Phenglawng	Mizo bamboo flute
46.	Pher	Mizo bamboo mat board
47.	Raw chaicheh	Bamboo tongue
48.	Rawchhem	Mizo bagpiper
49.	Sahdal thang	A snare for terrestrial bird

50.	Saihlum	Pellet
51.	Sairawkherh	Sairawkherh
52.	Samkhuih	Traditional comb
53.	Sa-um bur	Fermented pig fat jar
54.	Seki no	Mithun horn drinking vessel
55.	Suankual	Suankual
56.	Suk	Pestle
57.	Sum	Mortar
58.	Suvel	Cotton winding machine
59.	Tap / Tapchhak	Fireplace
60.	Tawtawrawt	Bamboo trumpet
61.	Thlangra	Winnowing tray
62.	Thul	Thul
63.	Tui um	Traditional water bottle
64.	Tuithawl	Mizo water gallon
65.	Tuiumdar	A string musical instrument
66.	Tuthlawh	A hoe
67.	Vaibel	Smoking pipe
68.	Vaihrik	A sieve
69.	Vaithang	A trap for killing rat
70.	Zu no	Beer cup
71.	Zubel	Traditional ceramic jar

4.3 Findings related to Objective 2:

Objective No.2 To identify the different mathematical activities embedded among different cultural materials of the Mizo tribe.

Table: 4.2

Mathematical activities embedded among different cultural materials of the Mizo tribe.

Sl No.	Name	Mathematical activities
1	Aiawt (Crab trap)	Aiawt means a bamboo trap for catching small fish and crabs. The trap consists of an open cylindrical basket. The top of the basket is filled with a conical funnel made of bamboo slats, which are kept wide enough apart by the flow of the water to allow crab and small fish to enter. Once aside, they cannot escape. The conical funnel is detachable and is removed to allow the fish or crab to be taken out. These traps are used in small rivers when the small fish are swarming.
2	Arbawm (Chicken basket)	Arbawm is a chicken basket made from small split bamboo. This is a home for a hen and chickens. The basket has a square-based and cylindrical body and also has a rectangular opening for in and out. Unlike a regular cylinder shape, it has a hemispherical top, which can occupy more space, and there used to be a circular opening for carrying the basket.
3	Baibel (Earthen pot)	Mizo Bai is a stew cooked from wild edible plants and seasoned with various herbs and spices. The pot that is used for making Bai is called Baibel. The local clay maker used to make it from clay with circular openings and having oval shapes bodies. It was very useful and was available in every house in earlier days.

4	Belval	Belval is made from long pieces of creeper from the forest. For making belval, there is no requirement for an artisan and it can simply be made by local people. There was no fixed size for Belval, and the size varied based on their needs. It was made in a circular shape and was used for the stand of a traditional Mizo clay pot.
5	Berhbu (Brass bowl)	Berhbu is a small bowl made from brass. It was used by the Mizo for measuring salt and for holding water for dampening cloth when weaving. It was hemispherical in shape with a circular opening.
6	Buhher Khawl (Wooden mortar)	Wooden mortar is a Mizo traditional material made from wood by local artisans. The body was cylindrical in shape, and there was a space for putting the rice, which was cleaned by this wooden mortar by twisting the mortar using the handle. It was believed that it saves time and energy instead of using pestle and mortar.
7	Buhtlei (Rice stirrer)	A rice stirrer is a kitchen item, and it was very useful in earlier days. It is made from wood and has a cylindrical handle. The body is made in an oval shape to contain rice. Though it is a kitchen material, but plays a very important role in the kitchen and is used every morning and evening by the time of having breakfast and dinner. It is not only used for stirring rice but sometimes used as a spoon for stirring other cooking vegetables, etc.
8	Chaicheh (Tongue/Nippers/ Pincers)	Chaicheh is a material used in the kitchen for holding and grabbing equipment. It is made in a very traditional style, made up of iron. It consists of two straight irons around one and a half

		feet long with a small parabolic shape at the top. It is also used for moving hot cooking pots and for taking charcoal out of the burning fire in the early times.
9	Chawthlengpui (Mizo plate/standard wooden plate)	Chawthlwngpui is a Mizo plate or a common wooden plate in the Mizo society of the bygone days. There could never be any distinction between the rich and the poor in meal-eating style. They sat together and shared the same food. Generally, thlanvawng (one kind of tree) was used for this plate. It is a circular shape at the top and digs around 1 inch deep from the top so that it can hold rice and other things. Also, there is a smaller circle for its leg so that it can stand perfectly, and there is a space in between by supported from the sides. The size varies by the size of the family.
10	Chempui (Dao)	The most utility materials in the Mizo society. These daos are made in the village forge from iron. The Chempui has a cylindrical handle that supports the sharp iron materials. The handles are made from the root of bamboo in a cylindrical shape. This is used for clearing the jungle, and the broad end is used for sowing the seeds in the ground.
11	Chhemthei	Chhemthei is the most straightforward kitchen material for Mizo and was originally made from bamboo. As time passed later used iron to make it. They made Chhemthei by cutting bamboo between the nodes to form a hollow cylinder for blowing the fire while cooking
12	Chhihri (Sieve)	Chhihri is a filtering tray, made of bamboo. It has a square base and opening, but the height varies, forming a cuboidal shape. It was useful for filtering and cleaning various edible items,

		especially when cooking. This Chhihri can be found in every household. Its sole purpose is to filter out rice from chaff.
13	Chingal Thlawr Bel (Leaching funnel)	Chingal means potash or lye leached from wood ashes. Thlawrbur means a leaching funnel. This leaching funnel is a conical-shaped basket made of bamboo, featuring a small cylindrical bamboo piece for hanging, and is used for making potash from wood ashes. This strong alkaline solution often served as soap for washing purposes in the past.
14	Darkhuang/ Zamluang (Musical drum)	Darkhuang, also known as Zamluang (Jamluang), is a large musical drum made from brass and used as part of the cultural activities of dance and festival revelry in the State of Mizoram in the northeastern part of India. It is a costly drum. The beating of this drum (dar) or gong is known in the local Mizo language as "Darkhuang-Tum". In ancient days, it was an important musical instrument used to convey or exchange messages. It is circular and has a hemispherical shape at the centre.
15	Darngun Kual (Spiral brass bangles)	Darngun Kual is a Mizo traditional brass bangle and is usually worn by women of well-to-do families. It is circular in shape and is made from brass.
16	Dawrawn	The dawrawn is another closed–weave carrying basket used by the Lushai's, both for storage as well as to bring in field produce. This basket is made in two sizes, the men's size and the women's size. It is a tall, narrow basket with a square base and circular rim. The diagonal of the base square measures around 190 mm, the rim diameter is around 420 mm, and its height is

		around 470 mm. The structure and method of construction are identical to those of the (closed weave carrying basket).
17	Fairel Bel (Earthen vessel/clean rice vessel)	Fairel Bel is the material where clean rice is kept ready for cooking and this belongs to the kitchen household. It is made from bamboo that has a square base, a circular opening, and a conical shape cover that protects rice from dust particles, insects, and rats. It is developed by weaving the thin bamboo sheets (stripes) together in a crisscross way together. It has four small bamboo bases (stand) as a support and balance to a square base.
18	Favah (Sickle)	A sickle is a Mizo farming tool having a curved blade and a bamboo handle. It's meant to be used with one hand, typically to harvest bundles of plants (like grasses or grains) by cutting them at the base. It is also used in the paddy field for cutting rice.
19	Fenthlir (Ladle/dipper)	Fenthlir (Ladle/Dipper) is a Mizo traditional mug with a long handle that was very useful in earlier days. It is made from a gourd, which is used for drawing water from the natural water holes. It has a hemispherical body and a cylindrical handle with a conical shape at the end. The gourd is initially dried and cleaned from the inside to prepare a hollow mug and then it is cut in a hemispherical shape along with a cylindrical handle.
20	Fungki (Gun powder container)	It is a gunpowder container made of a bison horn with a stopper, using a carving technique. It is conical in shape, and the surface is painted in red and black. The gunpowder container was used for keeping gunpowder by the time of hunting animals.

21	Hachhek (Adze)	Adze was a Mizo traditional tool used by woodworkers for cutting and trimming rough wooden planks, shaping and smoothing wooden surfaces, and splitting and opening out bamboo. It has a triangular head with a long bamboo handle.
22	Hershsawp (Mizo stool)	Herhsawp is a short cylinder stool made of two rings of cane held apart by bamboo splits. It needs a good artisan to make a Mizo stool. It is cylindrical in shape and has a rectangular space in between the posts with one closed end. The seat surface is made of rawhide stretched tight over the ring. It was very useful in earlier days.
23	Hmui (A spinning wheel)	Hmui or the spinning wheel is made from wood and bamboo cane, the actual spindle being made of iron. The stand of the wheel is also made of wood. It was used for extracting the thread. It is used scientifically to create thread from rolled cotton, which is hexagonal in shape.
24	Hnam (Basket strap)	A basket strap is a Mizo traditional material used for carrying different kinds of baskets. It was made from bamboo strips by the local artisan. It is rectangular in shape and very long, and can form a curve as well. The flat part was for the headrest and was joined with a bamboo rope.
25	Hnawhtawt (A trap for killing rats)	Hnawhtawt is a trap for killing rats. It was very useful in earlier days. It was made from bamboo. A strong lever was attached to the end of a hollow cylinder and was connected with a string that looked like a similar triangle. There was a circular opening for keeping the bait. A small hole was made, and a little string that worked as a trigger passed through the hole. By the time of eating the bait, the rats used to bite that string, and that's pulled the trigger.

26	Hreipui (Axe)	Hreipui is a traditional axe found in a Mizo society, used for cutting firewood into small pieces in rural areas. It contains a cylindrical bamboo as a handle in which an iron head is inserted in such a way that it can be used for cutting and smoothing the wooden surface.
27	Ipte Pui (Mizo traditional bag)	Ipte pui was made from available cloth. There are no perfect or actual sizes for the Mizo traditional bag. The size is varied depending on the needs of the family or per person. It was a locally made in a cuboidal shape, having a strong strap that would hold heavy things. It was usually used for carrying dao, food, water bottles, etc. by the time of working.
28	Kahpuk (Bamboo toy gun)	Kahpuk is a Mizo Bamboo toy gun made from a small bamboo. It is made by the elders for the children. It has a hollow cylindrical barrel and a handle that is usually used to be the size of a barrel. It also had a cylindrical stick with the size of a hollow cylinder but shorter than the barrel. To fire the bullet, the handle is pressed, and it is fired. With this, children used to play and enjoy their childhood. Children in rural areas are still enjoying Kahpuk.
29	Kaihbu (Lattu)	Lattu or spinning tops are used to play games in Mizoram. This has been a traditional game of the Mizo, which used to be liked and played by every kid, but now it is losing its importance and enjoyment due to the availability of the internet, but still enjoyed in rural areas. It was made from wood in a conical shape and a hemispherical top for balance.
30	Kalchhet (Stilt)	Walking on stilts is one of the Mizo games. The stilt is made from bamboo. These cylindrical bamboo sticks are specially designed in such a way that a small portion of the foot can be placed over that, and the remaining part is used as a tall handle for maintaining the coordination and

		balance of the player. This handle and the standing paddle are made of a single bamboo so that they can be strong enough to handle the weight of a person. With the help of this, children and adults used to play games in which they stood on the bamboo and used to walk or run with the help of a stilt.
31	Kho/Fawng (Square base small basket)	It is a Mizo basket used for measuring rice and used for keeping clean rice ready for cooking. Also, it can be used for keeping vegetables. Thin strips of bamboo are used to make this basket and require a skilled artisan. It has a square base, a cylindrical body, and a circular opening. Small baskets and very common and useful and were available in every house in earlier days.
32	Khuangpui (A common large drum)	Khuangpui is a Mizo traditional drum and is available in every church in Mizoram. It is made from wood and cowhide. The cylindrical drum was hollow, having a circular opening that was covered by cowhide and could produce sound by beating the drum.
33	Khuhhriang (Traditional bowl)	Khuhhriang **(**Mizo traditional bowl) is a traditional material of the Mizo culture used for keeping eatable materials. Earlier, it was made of clay, and in recent days it was made from aluminium by a local artisan. It was a kitchen item and mainly used for serving vegetables while dining. It was very useful in the early days. It has a circular opening and a hemispherical body to contain some vegetables with soup. Also, it has a small circular support as a stand, which combinedly attains the beautiful shapes of a bowl, which is slightly flattered in shape.
34	Khumbeu (Mizo cap)	Khumbeu is the traditional hat commonly worn by Lushai men. It is shaped like a peak cap and retains its shape even when not in use. It is formed in two layers, each made from bamboo

		woven in an open hexagonal weave. This hat is extremely delicately made with high-quality craftsmanship. It has a beautiful curve at the front and is decorated with a beautiful design.
35	Lensuah	It is a very famous triangular object that is made up of bamboo stripes and small bamboo sticks in such a way that the triangular shape has sufficient space to grasp. In Mizoram, it is used to catch fish from lakes and rivers. The materials are very handy in the Mizo society and are used on several occasions for catching fish.
36	Lunglehkha (Slate)	A slate is made from rock. It was rectangular and used as paper in earlier days, and was very useful for studying. The quality of the slate depends upon the artisan who made it.
37	Mau Haileng No (Ordinary bamboo cup)	Mau Haileng No is a Mizo traditional cup usually used for drinking Mizo traditional beer. It was made from bamboo, and the bamboo was cut before the nodes formed a cylinder. The other end has a diagonal cut semi-circular opening for easy pouring. The size can vary depending on the requirement, and there are no fixed sizes.
38	Mau Fian (Bamboo spoon)	Mau fian is a Mizo traditional bamboo spoon made from bamboo. The process of making a bamboo spoon was simple. The bamboo was cut before the nodes in a rectangular shape for the handle, and the other end was cut diagonally to form a right-angle shape for containing soup and other vegetables or meat at the time of having food.
39	Mizo In (Typical Mizo house)	The houses built by the Lushai tribe of Mizoram predominantly use bamboo and wood in their construction. Most of the houses are built on the slopes and are invariably supported by wooden posts of varied lengths so that the house is balanced horizontally with the level of the road. The

		rectangular doors and windows are usually of bamboo matting, and these are fastened against the wall. It may be noted that in some cases the floor, doors, and windows are made of wooden planks, while in others, split bamboos are used instead. The body of the hose is a cuboidal shape and a triangular shape at the top.
40	Nghaawt (Fish basket)	Nghaawt is a fish basket made from bamboo. It was the material where the fish was kept at the time of catching. Bamboo stripes are used by the local artisan to make fish baskets. It has a cuboidal body, a cylindrical neck, and a circular opening for the inlet and outlet. It was very useful in earlier days.
41	Nghawngkawl (Yoke)	It is a curved-shaped material made of wood, generally used for carrying heavy baskets. It is a kind of neck and shoulder support to hang the basket and carry it in hilly areas. It is generally a locally made product, very famous in the tribal culture
42	Ngotekherh	Ngotekherh is a popular traditional cloth of the Mizo people. It is a delicately sewn cloth or fabric that is woven on a loom. The original Ngotekherh was plain white, rectangular, with only two black stripes of 3 to 4 inches each running in a traverse direction at a distance of about 1/3rd of the whole length from both edges of the puan(cloth).
43	Pai Em / Emping (Closed-weave carrying basket)	The Paiem/Emping is a closed weave carrying basket used by the Lushai's of Mizoram to carry grain and other fields' produce. In Lushai, the word Em means basket, and Pai means without holes, and this basket is also called Emping. High-skill craftsman is required for this job. It has a square base with a stand for support. Split cane is used in the circular rim strengthening

		element, the weft elements of the side weave near the base, in bindings at the rim, and for strengthening the corners of the basket.
44	Paikawng (Open-weave carrying basket)	The paikawng is an open-weave carrying basket made and used by the Mizo tribe of Mizoram. This basket is generally used by women as a rough work basket for carrying firewood, bamboo water tubes, etc. The basket made entirely of bamboo outer splits is carried over the back with a strap resting on the head. The basket has an extremely strong combination which is very resistant to vertical loads. This is due to the construction pattern as well as the fact that fairly thick strips of bamboo are used. The Paikawng has a square base and transforms into a circle at the rim. To the craftsmen making this basket, the height may vary depending on the need and the user.
45	Phenglawng (Mizo bamboo flute)	Phenglawng is a traditional Mizo bamboo flute. It is made from a small bamboo cutting before the nodes forming a hollow cylinder. Originally, Phenglawng had only three circular holes producing three different sounds.
46	Pher (Bamboo mat board)	Pher is another important bamboo work and requires a good artisan to make one. It is made of split bamboo plaited together in around a 6ft square or sometimes in a rectangular shape, depending upon the needs of one another. It does not mean that the bamboo mat board must be square or rectangular. It is very useful for drying rice before cleaning the husk. In earlier days, the husk of rice was cleaned by using a pestle and mortar, but before doing that, they dried it under the sun by using a bamboo mat board.

47	Raw Caicheh (Bamboo tongue)	Raw Chaicheh is a material used in the kitchen for holding and grabbing equipment, it is made in a very traditional style made up of bamboo. It consists of two straight bamboos around one and a half feet long. It is also used for moving hot cooking pots and for taking charcoal out of the burning fire in the early times.
48	Rawchhem (Mizo bagpiper)	It is a Scotch bagpiper-like mouth organ or we can say a Mizo bagpiper. It is made of a dry hollow gourd into which are inserted nine hollow bamboo tubes of different sizes and lengths, five of which are fixed at the gourd of about 2 inches distance from the other four tubes both of which are tied together but slightly slanting outwards. To make different notes of sound, holes are made at the desired spot of the tubes. Blowing is done at the tapering end of the gourd. To produce sufficient sound a hard blow is required to be made and different notes of sound are made by blocking or opening the circular holes in the tube with fingers
49	Sahdal Thang (A snare for terrestrial birds)	Sahdal Thang is one of the most popular snares for Mizo. It was made from small and thin strips of bamboo converted as a rope. It can also be seen from the picture how the snare works. It had a curvy lever to support the circular shape snare and a straight lock at the bottom and that was a trigger as well. As soon as the birds crossed the path touching the trigger, the bird was caught.
50	Saihlum (Pellet)	Saihlum(pellet) was usually made and used by children from clay in a spherical shape. The process of making pellets is by taking clay from the forest where the clay was softer and smoothy (Sawntlung lei) for making spherical-shaped pellets. The clay was then mixed with water to prepare pellets. After that, they roll in a spherical shape and dry by putting them under

		the sun or by heating in a fireplace. After it dries it becomes ready to be used, mainly these pellets are used for hunting birds.
51	Sairawkherh	The sairawkherh is a bow made by the Lushai tribe of Mizoram and used to hunt birds and small animals. Unlike the usual bow, these fire clay pellets instead of arrows. It consists of a strong beam made from a wide splint of bamboo, which is held bent(curved) in tension by a bow-string made from a fine bamboo split. The beam is made from rawthing bamboo while the bowstring is from sairil bamboo. The bow requires some skill to operate, as it has to be twisted slightly to one side to permit the pellet to sail past without striking the beam
52	Samkhuih (Traditional comb)	Samkhuih is a Mizo traditional comb and is made from bamboo. In earlier days, women were not the only ones who kept their hair long, even men were keeping their hair long enough for using the comb which was useful for both. Also, they used to comb their hair in the morning by exposing it to the sun, especially in winter. The process of making a traditional comb was that bamboo was cut nearly the size of a toothpick into a cylindrical structure with a conical shape spike that was tied in the straight-line frame leaving a space for holding.
53	Sa-um Bur (Fermented pig fat jar)	Sa-um bur is made from a bottled gourd. The process of making sa-um is that Fats of pigs are mainly collected from the inner abdominal portion (sometimes fats from other parts of the pig's body were also used), cooked and torn/chopped into pieces, and placed in a special container called "Sa-Um Bur". It is an important component in Mizo society and is been used till the present day. It has a circular open so that it can easily be taken out and has a spherical body.

54	Seki No (Mithun horn drinking vessel)	Seki no (Mithun horn drinking vessel) is a traditional Mizo rice beer cup used for drinking different kinds of Mizo traditional beer. Mithun (Bos frontalis), a magnificent semi-domesticated and unique bovine species, is believed to have originated more than 8000 years ago. Mithun is a valued animal in the life of the tribal people of Mizoram. The Mithun horn is a conical shape structure material and was very useful in earlier days.
55	Suankual	Suankual is also a Mizo traditional kitchen material and it belongs to the family of kitchen tongues/nippers. It is made from two equal irons that are straight in the middle and the front end and has a semi-oval shape in the handle that is very usable for moving the bigger shaped hot and heavy pots while cooking in the fireplace. It is very useful for carrying pots with bigger nozzles for removing them from the fire. Sometimes, it is also used for holding materials.
56	Suk (Pestle)	The pestle was made from strong wood in a cylindrical shape having a smaller cylindrical handle with a hemispherical end. In earlier days, harvesting or jhum cultivation or having paddy fields were the main earning for a living and it was practiced by every family, though they did not have a plain area for paddy, they used to plant in the mountainside. After all the hard work was done, the pestle was needed and played an important role in those days. It is mainly used for cleaning the husk by putting the rice in the mortar and by grinding with a pestle.
57	Sum (Mortar)	Mizo traditional mortar is made from a big and strong wood. The first process was taking a big log from the forest and cutting it into a cylindrical shape. After that, the body was designed into an inverted conical shape having a cylindrical stand with a conical spike. The purpose of the

		spike is for a smooth landing and a kind of lock since they used to dig the mud for placing the motor to avoid shaking and moving while working to remove the husk.
58	Suvel (Cotton winding machine)	Suvel is a revolving tool with four extendable arms around which a skein of cotton yarn is put to make the yarn into a ball. There may be two or three kinds of suvel. It is made from wood and bamboo. It has a cylindrical post and a wooden stand as a base. Four holes are made in a cylindrical post to put the straight arms perpendicular to each other forming a vertically opposite angle.
59	Tap/ Tapchhak (Fireplace)	The fireplace is one of the most important and useful materials that every family had in the earlier days and this is the place where they cooked. It has a square or rectangular base made from clay and is a little higher than the floor. Also, it has a three-found stone or clay to place a clay pot for cooking. Above the stone, it has a cuboidal shape rack where necessary kitchen material is placed. The rack is also used for keeping firewood.
60	Tawtawrawt (Bamboo trumpet)	This is a bamboo trumpet. Several bamboo hollow cylindrical tubes are cut off. The bigger tubes are joined by inserting them into the smaller tubes. Many bamboo tubes are joined one after another till the last tube happens to be the size of a forefinger from where the trumpet is to be blown. A dry empty gourd, the bottom part being cut off is joined with the bigger end of the bamboo tube. The whole length can be more than five feet. It is usually blown in the jhum to tell their whereabouts and presence and also to pass the time and relieve their loneliness.

61	Thlangra	The thlangra is a winnowing tray used by the Lushai tribe of Mizoram. The triangular thlangra requires manufacturing skills that only a few craftsmen have. The rawthing bamboo is used because of the resistance of the thin strip of this bamboo to impact loads. The strips from the mat are cut from green bamboo, one set from the outer layer and the other from the inner layer. The two thick strips used for the trim are also cut, bent and tied into the required triangular shape. All the strips are thoroughly dried before making the thlangra so that there is no shrinkage later.
62	Thul	Thul is one of the most treasured items in every household in earlier days. It was always kept near Khumpui (parents' bed) indicating the safest and most secure place in the house. It was indispensable for a young woman to bring with her to her marriage. It was made by weaving the bamboo stripes together in a crisscross way together. It has four small bamboo bases (stand) as a support and balance to a square base. It has a hemispherical-shaped cover that protects treasured from dust particles, insects, rats, etc.
63	Tuium (Traditional water bottle)	'Tui' is water and 'um' is some kind of bottle and can be translated as Mizo water bottle. It was very useful in the earlier days, and they were used for carrying water for cooking, drinking, and also for important uses. In particular, carrying water with traditional water bottles was done by the children. Those water bottles are made from bamboo and they used to be cut diagonally before the nodes; the diagonal cutting is for easy pouring. The size can vary depending on the bamboo and there are no fixed sizes.

64	Tuithawl (Water gallon)	Tuithawl is a Mizo water Gallon and is made from a bottled gourd. It has a circular opening for the intake and outlet of water and has a spherical body that can contain water. Mizo's are hard-working people in cultivating and crops growing. The daily routine in those days was to take care of the crops and the only available material for carrying water was the Water Gallon which was very useful in those days.
65	Tuiumdar (A string musical instrument)	Tuiumdar is a Mizo traditional musical instrument made from bamboo. Bamboo was cut between the nodes forming a hollow cylinder. The bamboo itself provides a string (small bamboo stripes) and there is an opening for sound waves to travel in and out that makes the musical notes.
66	Tuthlawh (A hoe)	A Hoe is a traditional tool of the Mizo and used for cleaning the garden and surroundings. It has a triangular head made from metal and a long bamboo handle. It can also be used for shoveling, digging, stirring, etc
67	Vaibel (Smoking pipe)	It is a Mizo smoking pipe made from Bamboo. It was very common for the elders and used to smoke using Smoking pipes. A small hollow cylindrical bamboo was used for the pipe, and a bigger cylinder was used for the container. It is a combination of two cylinders of different height and radius. It can also be mentioned that the material is purely cylindrical.
68	Vaihrik (A sieve)	This is a bamboo-based circular tray common in Mizo culture and society, basically used for drying and winnowing rice and other eating materials like mazes, pulses, carrying and drying

		chilies, etc. It has a small circular boundary as a covering to the tray which is tied with thread to hold and make the fencing strong and durable.
69	Vaithang (A trap for killing rat)	Vaithang is one of the most common traps for killing rats. It is still used in some parts of rural areas of Mizoram especially where paddy fields are available. Vaithang is made from bamboo and has a strong and long straight-line post that can hold rats and a pointed head to be placed in their path. The main body of a trap is a right-angle triangle shape and the materials used are bamboo stripes. The string is attached at the end of the beam which can form a beautiful curve to trap the rat in a triangular shape bamboo stripe.
70	Zu No (Beer cup)	Zu no is a beer cup used for drinking Mizo traditional beer. It basically originates from Myanmar and is mostly used in the Mizo society for drinking liquor. It is small in size and very handy to handle in one palm. This cup seems to be an ideal hemispherical small bowl that can be very useful while teaching the hemisphere and its related aspects in mathematics at the elementary level.
71	Zubel (Traditional ceramic jar)	Mizoram is famous for its traditional beer known as zu(wine) and is prepared by fermenting rice, millet, or maize, and the container used for keeping this is called zubel. The local clay maker used to make it from clay with circular openings and having oval shapes bodies. Also, they used to make two handles and used to decorate the body in a diamond-cutting shape using bamboo stripes. It is very useful for keeping and carrying the zu (wine) in the Mizo society.

4.3.1 Discussion:

The objective aimed at identifying the various mathematical activities inherent in the cultural materials of the Mizo tribe, illustrating the profound connection between mathematical thought and daily living, as well as traditional customs. Several studies have indicated that mathematical knowledge is frequently integrated into cultural practices and tools, transmitted between generations (D'Ambrosio, 2001; Ascher, 1991). The cultural artifacts, tools, crafts, and rituals of the Mizo people provide a rich source of mathematical concepts that are frequently overlooked in conventional educational settings.

Measurement, counting systems, patterns, symmetry, and spatial thinking are commonly observed in weaving, basketry, and agricultural practices. The crafting of traditional attire, the building of houses, or the preparation of ceremonial items requires accurate computation, estimation, and proportionate reasoning (Núñez & García, 2018). These activities illustrate the practical application of mathematical thinking, frequently utilising indigenous knowledge and accessible resources. The study highlights the significance of acknowledging local knowledge systems in mathematics teaching by identifying these inherent mathematical activities. Incorporating culturally pertinent contexts into instruction enhances the significance and relatability of mathematics for students, hence augmenting engagement and conceptual comprehension (Barton, 1996; Lipka, 2002).

In conclusion, recognising mathematical activities within the cultural artefacts of the Mizo tribe provides significant insights into how traditional practices foster mathematical cognition. This underscores the interconnection between culture and mathematics, suggesting that incorporating indigenous traditions might enrich educational experiences while safeguarding cultural legacy (D'Ambrosio, 2001).

4.4 Findings related to Objective 3:

Objective No. 3: To identify the connotation of mathematical concepts at the Class VIII level with existing cultural mathematical elements of the Mizo tribe.

Table: 4.3

Connotation of mathematical concepts at the Class VIII level

Sl no	Mathematical Components	Mathematical Elements of Mizo Culture	Mathematical Contents in the Textbook	Connotation	Discussion
1	Cylinder, Cone, Circle	Aiawt (Crab trap)	1. Understanding quadrilaterals 2. Practical Geometry 3. Visualising solid shapes 4. Mensuration	Aiawt is a combination of a cylinder and a cone. It can be used to demonstrate a cone and a cylinder. It can also be used for calculating the volume and surface area of a cylinder.	1. Model of a cylinder. 2. Model of a cone. 3. Calculating the volume and surface area of a cylinder. 4. Calculating the volume and surface area of a cone.
2	Square, Rectangle, Cylinder	Arbawm (Chicken basket)	1. Understanding quadrilaterals 2. Practical Geometry	It is applicable for explaining squares, rectangles, hemispheres, and cylinder. The material is a combination of an important geometric figure and that	1. Model of a cylinder. 2. Model of a hemisphere. 3. Calculating the volume and surface area of a cylinder.

			3. Visualising solid shapes 4. Mensuration	explains how important can be in explaining the above-mentioned geometric figures. It can also be used for calculating the volume and surface area of a cylinder and a hemisphere.	4. Calculating the volume and surface area of a hemisphere.
3	Circle, Oval	Baibel (Earthen pot)	1. Understanding quadrilaterals 2. Practical Geometry 3. Visualising solid shapes 4. Mensuration	This type of object can be used in teaching a lesson on circles and for explaining oval shapes. The oval shape can be somehow confusing for the learner, especially in lower classes. By showing the above materials, it is believed that the learner can have a clear-cut idea of how an oval looks (visualizing the structural aspects of an oval). Also, it has a circular opening that can be used for explaining a circle and for countering the circumference and area of a circle.	1. Model of oval shape. 2. Finding the area and perimeter of a circle.

4	Circle	Belval	1. Visualising solid shapes 2. Mensuration 3. Introduction to Graphs	It can be used to demonstrate a circle since it has a circular shape and can also be used to counter the volume and surface area of a circle. It can be seen and noted that circular shapes were very useful in earlier days.	Model of a circle.
5	Circle, Hemisphere	Berhbu (Brass bowl)	1. Understanding quadrilaterals 2. Visualising solid shapes 3. Mensuration	It can be used for demonstrating circles and hemispheres. Also, it can be used for countering the volume and surface area of a hemisphere. The circular opening can be used to explain the circumference and area of the circle.	1. Computing the volume, curved surface area, and whole surface area of the hemisphere. 2. Countering the circumference and area of a circle. 3. Combining the different kinds of geometrical figures and making a meaningful shape.
6	Cylinder	Buhher Khawl	1. Visualising solid shapes	The material is made up of a combination of two cylindrical and	1. Model of a cylinder.

		(Wooden mortar)	2. Mensuration	can be used for demonstrating a cylinder. It can also be used for calculating the volume and surface area of a cylinder.	2. Calculating the volume and surface area of a cylinder.
7	Cylinder, Curve, Oval	Buhtlei (Rice stirrer)	1. Understanding quadrilaterals 2. Practical Geometry 3. Visualising solid shapes 4. Mensuration	It can be used for demonstrating an oval shape. It can also be used for calculating the volume and surface area of a triangle	1. Model of an oval. 2. Model of a cylinder. 3. Calculating the volume and surface area of a cylinder.
8	Straight Line, Angles and Semi-oval	Chaicheh (Tongue/Nippers/Pincers)	1. Introduction to graphs 2. Mensuration 3. Understanding quadrilaterals 4. Practical Geometry	Teaching straight lines and angles. It can also be used for showing and visualizing the intersection of two lines and the formation of angles by them.	It is movable and can make different angles like 30, 45º, 60º, 90º. etc., and can be used to demonstrate and measure the different angles in the classrooms

9	Circle, Frustum	Chawthlengpui (Mizo plate/standard wooden plate)	1. Mensuration 2. Visualising solid shapes	It can be used to explain the volume and surface area of a frustum because two circles of different radii can be seen from the top and can be used for explaining the circle.	Model for frustum and circle and can be used for calculating the volume and surface area of a frustum.
10	Arc of a Circle, Quadrilateral, Cylinder	Chempui (Dao)	1. Understanding quadrilaterals 2. Practical Geometry 3. Visualising solid shapes 4. Mensuration	It will be applicable in teaching the arc of a circle, quadrilateral, and cylinder. Though it is not a right circular cylinder, it can be imagined as a cylinder.	Model of a cylinder and calculating the volume and surface area of a cylinder.
11	Hollow cylinder, circle	Chhemthei	1. Visualising solid shapes 2. Mensuration	It can be used in teaching circles and cylinders.	Model of a hollow cylinder.
12	Square, Cuboid, Rectangle	Chhihri (Sieve)	1. Understanding quadrilaterals 2. Practical Geometry	A sieve is a model of a square and a cuboid. It can be used for demonstrating a square and a cuboid. It can also be used for calculating the	1. Model of a square/rectangle.

			3. Visualising solid shapes 4. Mensuration	volume and surface area of a cuboid. It can also be applicable for computing the area and perimeter of a square/rectangle.	2. Calculating the area and perimeter of a square/ rectangle. 3. Model of a cuboid. 4. Computing the capacity and surface area of a cuboid.
13	Cone, Cylinder	Chingal Thlawr Bel (Leaching funnel)	1. Visualising solid shapes 2. Mensuration	It is applicable for teaching-learning cones and cylinders because it has a perfect conical shape and structure. It can also be used for calculating the volume and surface area of cone and cylinder.	1. Model of a cone 2. Model of a cylinder. 3. Calculating the volume and surface area of a cylinder and a cone.

14	Hemisphere, Hollow Cylinder	Darkhuang/Zamluang (Musical drum)	1. Visualising solid shapes 2. Mensuration	It is applicable for explaining hemispheres and cylinders. The material is made of a combination of an important geometric figure and which explains how important it can be in explaining the above-mentioned geometric figures. It can be used for calculating the volume and surface area of a hemisphere. It can also be used for calculating the circumference and area of a circle.	1. Model of a cylinder. 2. Model of a hemisphere. 3. Calculating the volume and surface area of a cylinder. 4. Calculating the volume and surface area of a hemisphere
15	Circle	Darngun Kual (Spiral brass bangles)	1. Understanding quadrilaterals 2. Data handling 3. Introduction to graphs	It can be used to demonstrate a circle. Since it is circular, it can also be used for computing the area and circumference of a circle.	1. Model of a circle. 2. Calculating the area of a circle. 3. Calculating the circumference of a circle.
16	Square, Circle, Straight line, frustum	Dawrawn	1. Understanding quadrilaterals	Dawrawn can be used for demonstrating square, circle, and straight lines. It can also be used for	1. Computing the area of squares and circles. 2. Demonstrating circle.

			2. Practical Geometry 3. Visualising solid shapes 4. Mensuration	calculating the areas of squares and circles.	
17	Square, Circle, and cone	Fairel Bel (Earthen vessel/clean rice vessel)	1. Practical Geometry 2. Visualising solid shapes 3. Mensuration	It can be used to demonstrate circles, squares, and cones.	Calculating the capacity and lateral surface area of a cone
18	Curve, Cylinder.	Favah (Sickle)	1. Practical Geometry 2. Visualising solid shapes 3. Mensuration	Favah can be used for demonstrating cylinders and curves. Bamboo handles can be used to calculate the volume and surface area of a cylinder. The metal can also be used to explain the curve.	Model of a cylinder and curve.
19	Hemisphere, Circle, Cylinder	Fenthlir (Ladle/dipper)	1. Mensuration 2. Visualising solid shapes	This material can be used for demonstrating hemispherical shapes	Calculating the surface area and the volume of a hemisphere.

				and explaining the related mathematical aspects	
20	Cone	Fungki (Gun powder container)	1. Visualising solid shapes 2. Mensuration	It is an application for teaching and learning conical and circular shape objects. The conical-look materials can help the learner understand the shape of a cone and a circle. It can be used for calculating the volume and surface area of a cone and countering the perimeter and area of a circle.	1. Calculate the volume and the surface area of the cone. 2. Computing the area and perimeter of a circle.
21	Cylinder, Curve, Triangle	Hachhek (Adze)	1. Practical Geometry 2. Visualising solid shapes 3. Mensuration	Adze can be used for explaining cylinders, curves, and triangles. The bamboo handle is cylindrical and can be used for calculating the volume and surface of a cylinder. The head can also be used for explaining triangles and a curve.	Model of a cylinder, triangle, and curve.

22	Cylinder, Circle, Rectangle	Hershsawp (Mizo stool)	1. Understanding quadrilaterals 2. Practical Geometry 3. Visualising solid shapes 4. Mensuration	It is applicable for demonstrating a cylinder and a rectangle. It can also be used for calculating the volume and surface area of a cylinder. The rectangular-shaped post can also be used for calculating the area and perimeter of a rectangle. The cylindrical shape is very relevant in the present-day mathematics curriculum. By knowing the shape of the cylinder, the learner can separate the object easily.	1. Model of a cylinder. 2. Model of a rectangle. 3. Calculating the volume and surface area of a cylinder. 4. Calculating the area and perimeter of a rectangle.
24	Rectangle, curve	Hnam (Basket strap)	1. Understanding quadrilaterals 2. Practical Geometry 3. Visualising solid shapes	A basket strap can be used for demonstrating a rectangle and a curve. It can help the learner understand a rectangle. It can also be used for computing the area and perimeter of a rectangle. The strap is	1. Model of a rectangle. 2. Calculating the area and perimeter of a rectangle.

				very flexible, and it can form a beautiful parabolic curve, circle, etc.	
25	Hollow Cylinder, Circle, Similar Triangle	Hnawhtawt (A trap for killing rats)	1. Visualising solid shapes 2. Mensuration	Hnawhtawt is applicable for demonstrating a hollow cylinder, a circle, and a similar triangle. It can be used for computing the area and circumference of a triangle. It can also be used for calculating the surface area of a hollow cylinder.	1. Model of a circle. 2. Models of a hollow cylinder. 3. Calculating the area and circumference of a circle.
26	Cylinder, Curve, Triangle	Hreipui (Axe)	1. Practical Geometry 2. Visualising solid shapes 3. Mensuration	Axe can be used for explaining cylinders, curves, and triangles.	The bamboo handle is cylindrical and can be used to calculate the volume and surface area of a cylinder. The head can also be used for explaining triangles and a curve.
27	Cuboid, curve	Ipte Pui (Mizo traditional bag)	1. Practical Geometry	The Mizo traditional bag can be used for explaining cuboids and curves. It can also be used for calculating the	Model of a cuboid

			2. Visualising solid shapes 3. Mensuration	volume and surface area of a cuboid. The strap can also form a parabolic curve.	
28	Hollow Cylinder, Circle, Cylinder	Kahpuk (Bamboo toy gun)	1. Practical Geometry 2. Visualising solid shapes 3. Mensuration	The material is made up of a combination of a cylindrical family and can be used for demonstrating a hollow cylinder and a cylinder. It can also be used for calculating the volume and surface area of a cylinder.	1. Model of a cylinder. 2. Model of a hollow cylinder. 3. Calculating the volume and surface area of a cylinder.
29	Cone	Kaihbu (Lattu)	1. Visualising solid shapes 2. Mensuration	It has a shape of inverted conical shape and a circular opening at the top that can be used for demonstrating a cone and a circle. It can also be used for countering the volume and surface area of a cone. The perimeter and area of a circle can be calculated using this material.	1. Model of a cone 2. Calculating the area and volume of a cone.
30	Hollow Cylinder and	Kalchhet (Stilt)	1. Practical Geometry	The material is made up of a bamboo which is sharpened at the top for	1. Model of a cylinder.

	Cylindrical structure		2. Visualising solid shapes 3. Mensuration	making a handle and adjusted as a paddle for putting the foot. It can be generally utilised for explaining cylinder and straight lines as well as the concept of symmetry (as it works in a pair for two legs), both are symmetrical geometrically. It can also be used for demonstrating a hollow cylinder, and can be used for demonstrating and calculating the volume and surface area of a cylinder.	2. Calculating the volume and surface area of a cylinder.
31	Square, circle, and cylinder	Kho/Fawng (Square base small basket)	1. Understanding quadrilaterals 2. Practical Geometry 3. Visualising solid shapes 4. Mensuration	It can be used for teaching and learning mathematical components such as squares, circles, and cylinders.	Model of a square and computing the area, volume, and circumference of a circle.

32	Hollow Cylinder, Circle	Khuangpui (A common large drum)	1. Visualising solid shapes 2. Mensuration	Khuangpui is a hollow cylinder and can be used for demonstrating a hollow cylinder. It can also be used for computing the lateral surface area of a cylinder.	1. Model of a cylinder. 2. Calculating the curved surface area of a cylinder.
33	Circle, Hemisphere	Khuhhriang (Traditional bowl)	1. Practical Geometry 2. Visualising solid shapes 3. Mensuration	It can be used for demonstrating circles and hemispheres. Also, it can be used for countering the volume and surface area of a hemisphere.	Countering the circumference and area of a circle. Combining the different kinds of geometrical figures and making a meaningful shape.
34	Cylinder, Curve, hexagon	Khumbeu (Mizo cap)	1. Understanding quadrilaterals 2. Practical Geometry 3. Visualising solid shapes 4. Mensuration	Mizo cap can be used for demonstrating curves, hexagons, and cylinders. It can also be used for countering the surface area of a cylinder. Many hexagonal shapes can be found and they can be used for counting.	1. Model of curve 2. Model of hexagon. 3. Calculating the surface area of a cylinder. 4. Applicable for counting.

35	Triangle, Rectangle, the intersection of lines, volume of a three-dimensional triangle	Lensuah	1. Understanding quadrilaterals 2. Practical Geometry 3. Data handling 4. Visualising solid shapes 5. Mensuration	This material can be used for demonstrating the Triangle, Rectangle, intersection of lines, and the volume of a three-dimensional triangle. A demonstration of the frustum and its related aspects like the area of a frustum, the radius, and the diameter of a rim can be done. Calculation of volume and surface area can also be done.	1. Calculating the volume of a three-dimensional triangle. 2. Finding the area of a rectangle.
36	Rectangle	Lunglehkha (Slate)	1. Understanding quadrilaterals 2. Practical Geometry	Slate can be used for demonstrating a rectangle. It can help the learner understand a rectangle. It can also be used for computing the area and perimeter of a rectangle.	1. Model of a rectangle. 2. Calculating the area of a rectangle. 3. Calculating the perimeter of a rectangle.
37	Cylinder, diagonally cut	Mau Haileng No	1. Visualising solid shapes	It is applicable for demonstrating a cylinder. Also, the learner can easily	1. Model of a cylinder.

	semi-circular shape	(Ordinary bamboo cup)	2. Mensuration	understand the surface area of a cylinder just by seeing that object and can also counter the volume or capacity of a cylinder. It is very relevant in the present-day mathematics curriculum that by knowing the shape of the cylinder, the learner can separate the object easily. Also, there are many cylinder-shaped objects in modern days, and with the concept's knowledge, it will be easy to understand.	2. Calculating the volume and surface area of a cylinder
38	Rectangle, Right Angle (90^0)	Mau Fian (Bamboo spoon)	1. Understanding quadrilaterals 2. Practical Geometry	Bamboo spoon was can be used for explaining a rectangle and a right angle. It can also be used for calculating the area and perimeter of a rectangle. Since it has a perfect 90^0 it can be a role model to demonstrate right angles.	1. Model of a Rectangle. 2. Perfect materials for demonstrating the right angle.

39	Rectangle, Cuboid, And Triangle	Mizo In (Typical Mizo house)	1. Understanding quadrilaterals 2. Practical Geometry 3. Visualising solid shapes 4. Mensuration	It will be applicable in a cuboid, rectangle, and triangle. It is relevant in the mathematics aspects like calculating the curved surface area and volume of a cuboid. It can also be used for computing the area of a rectangle and a triangle.	1. Computing the area of a rectangle and a square. 2. Calculating the volume and surface area of a cuboid.
40	Cuboid, Circle, cylinder	Nghaawt (Fish basket)	1. Visualising solid shapes 2. Mensuration	Having a cuboidal body, a cylindrical neck, and a circular opening it can be used for demonstrating cuboid, cylinder, and circle. It can be used for calculating the volume and surface area of a cuboid and a cylinder. It can also be used for computing the area and circumference of a circle.	1. Model of a circle. 2. Calculating the area of a circle. 3. Model of cuboid. 4. Calculating the volume and surface area of a cuboid.
41	Semicircle, curve	Nghawngkawl (Yoke)	1. Understanding quadrilaterals 2. Practical Geometry	This kind of material can be used for explaining unusual geometrical shapes as well as semicircles and curves.	1. Model of a semicircle. 2. Unusual mathematical curves and geometrical shapes.

42	Straight Line, Square, Rectangle	Ngotekherh	1. Understanding Quadrilaterals 2. Practical geometry 3. Visualising solid shapes 4. Introduction to graphs	Ngotekherh can be used for demonstrating a square and a rectangle. Numbers of squares and rectangles are available in this material and can be used for counting. It can also be used for calculating the area and perimeter of rectangles and squares.	1. Model of a rectangle and 2. Model of a square.
43	Square, Circle, straight line	Pai Em / Emping (Closed-weave carrying basket)	1. Understanding quadrilaterals 2. Practical Geometry 3. Data handling 4. Visualising solid shapes 5. Mensuration	Paiem/Emping can be used for demonstrating square, circle, and straight lines. It can also be used for calculating the area of squares and circles.	1. Computing the area of squares and circles. 2. Demonstrating a circle.
44	Square, Straight lines, symmetry,	Paikawng	1. Understanding quadrilaterals	This material can be used for demonstrating circles, squares, straight lines, symmetry, counting,	1. Model of a frustum.

	counting, arranging the sticks (bamboo sticks), frustum, sections of frustum	(Open-weave carrying basket)	2. Practical Geometry 3. Data handling 4. Visualising solid shapes 5. Mensuration	arranging the sticks (bamboo sticks), frustum, and sections of frustum. As well as demonstration of the frustum and its related aspects like the area of a frustum, radius, and diameter of a rim can be done. Calculation of volume and surface area can also be done.	2. Calculating the volume, area, and surface area of a frustum.
45	Hollow Cylinder, Circle	Phenglawng (Mizo bamboo flute)	1. Understanding quadrilaterals 2. Visualising solid shapes 3. Mensuration	The Bamboo Flute is applicable for teaching a hollow cylinder and a circle since it has a circular opening. It can be used for computing the surface area of a hollow cylinder. It can also be used for calculating the circumference and area of a circle.	1. Model of a hollow cylinder. 2. Calculating the surface area of a hollow cylinder. 3. Calculating the circumference and area of a circle.
46	Square or Rectangle	Pher (Bamboo mat board)	1. Understanding quadrilaterals	Pher can be used for demonstrating squares or rectangles.	Model of a rectangle/square and can be used to calculate

			2. Practical Geometry 3. Visualising solid shapes 4. Mensuration 5. Introduction to graphs.		the area and perimeter of a square/rectangle.
47	Straight Line, Angles (can be placed at different angles), Semi-oval	Raw Caicheh (Bamboo tongue)	1. Understanding quadrilaterals 2. Practical Geometry 3. Visualising solid shapes 4. Mensuration	It is very much relevant in the present day's geometry that with the help of that object, the learners can have a clear understanding, and the importance of straight lines and different angles can be demonstrated from it. Since it is movable and can make different angles like 30 °, 45°, 60°, 90°. etc., and can be used to demonstrate and measure the different angles in the classrooms. It can also be used for showing and	1. Demonstration and measurement of angles 2. Showing the intersection of the two straight lines.

				visualizing the intersection of two lines and the formation of angles by them. The Chaicheh can be useful in teaching geometry to elementary students.	
48	Hollow Cylinder, Circle, and Oval	Rawchhem (Mizo bagpiper)	1. Understanding quadrilaterals 2. Visualising solid shapes 3. Mensuration	Rawchhem is a combination of different shapes of hollow cylinder and oval. It can be used for demonstrating circles, hollow cylinders, and oval-shaped figures. It is applicable for computing the volume and surface area of a cylinder.	1. Cylindrical model. 2. Model of a different shape circle. 3. Calculating the volume and surface area of a cylinder.
49	Circle, Straight Line, Curve	Sahdal Thang (A snare for terrestrial birds)	1. Understanding quadrilaterals 2. Practical Geometry	It can be used to demonstrate a circle, straight line, and curve. The angle of the curve is very flexible and can produce different parabolic curves depending upon the choice. It can also be used for calculating the area and perimeter of a circle.	1. Model of a circle. 2. Calculating the area of a circle. 3. Calculating the circumference of a circle.

50	Sphere	Saihlum (Pellet)	1. Visualising solid shapes	It can be used for teaching a sphere since it is a completely spherical object and is very simple and easy to understand.	Perfect model of a sphere and can be used for calculating the volume and surface area of a sphere.
51	Curve	Sairawkherh	1. Understanding quadrilaterals 2. Introduction to graphs.	It can be used for demonstrating different parabolic curves since there is a string that can be pulled or adjusted to different angles.	1. Model of curve. 2. Different parabolic curves can be made.
52	Straight line, cone, triangle, cylinder	Samkhuih (Traditional comb)	1. Introduction to graphs 2. Mensuration 3. Understanding quadrilaterals 4. Practical Geometry 5. Data Handling	Demonstrating straight lines, small cones, circles, and cylinders. It is also applicable for counting.	It can be a good example of showing how small geometric objects can play an important role like the small cone in this comb mixing with a small cylinder. Though they are very small but they still did not lose their property. Also, there is a straight line and a triangular top at the end.

53	Circle, Sphere, Curve	Sa-um Bur (Fermented pig fat jar)	1. Practical Geometry 2. Visualising solid shapes 3. Mensuration	It will be applicable in a teaching circle, triangle, and sphere. It is relevant in the mathematics aspects, like calculating the curved surface area and volume.	1. Calculation of curved surface area and volume 2. Representation of curved surface area and volume
54	Circle, Cone	Seki No (Mithun horn drinking vessel)	1. Mensuration 2. Visualising solid shapes	It is an application for teaching and learning conical and circular shape objects. The conical-look materials can help the learner understand the shape of a cone and a circle.	1. Calculate the volume and the surface area of the cone 2. Computing the area and perimeter of a circle.
55	Oval, Semi-oval, Straight Lines, Angles, and Curves	Suankual	1. Introduction to graphs 2. Mensuration 3. Understanding quadrilaterals 4. Practical Geometry	Demonstration of different mathematical concepts in geometry, like oval, semi-oval, straight lines, angles, and curves.	It is a combination of semi-oval shapes and straight lines and a complete oval shape can be formed depending upon the angles.
56	Cylinder, Hemisphere	Suk (Pestle)		It can be used for demonstrating a cylinder and a hemisphere since it has	Model of a cylinder and a hemisphere. The perfect

			1. Visualizing solid shapes 2. Mensuration	a cylindrical and hemispherical shape. It can also be used for calculating the volume and surface area of cylindrical and hemispheres. Also, it is a perfect combination of two geometrical shapes that form a relevant and beautiful shape.	combination of cylinder and hemisphere.
57	Inverted Cone, Circle	Sum (Mortar)	1. Visualising solid shapes 2. Mensuration	It has a shape of inverted conical shape and a circular opening at the top that can be used for demonstrating cones and circles. It can also be used for countering the volume and surface area of a cone.	Model of a cone.
58	Cylinder, Perpendicular, Straight Line, and Vertically	Suvel (Cotton winding machine)	1. Understanding quadrilaterals 2. Practical Geometry	Suvel contains different mathematical shapes and structures and can be used for demonstrating Cylinder, Perpendicular, Straight Line, and Vertically Opposite Angle (V.O.A). It	1. Model of a cylinder. 2. Calculating the volume and surface area of a cylinder.

	Opposite Angle (V.O.A)		3. Visualising solid shapes 4. Mensuration	can also be used for calculating the volume and lateral surface area of a cylinder. Since the arms are intersecting each other, the right angle and the vertically opposite angle can be seen.	3. Contain 90^0, perpendicular, and vertically opposite angles.
59	Square, Rectangle, Cuboid	Tap/ Tapchhak (Fireplace)	1. Understanding quadrilaterals 2. Practical Geometry 3. Visualising solid shapes 4. Mensuration	It can be used to demonstrate squares, rectangles, and cuboids. Also, the students might be able to counter the volume and surface area of the cuboid. It can also be used for calculating the perimeter and area of a rectangle and a square.	1. Model of a cuboid 2. Model of a square or rectangle.
60	Hollow Cylinder, Circle	Tawtawrawt (Bamboo trumpet)	1. Visualising solid shapes 2. Mensuration	The bamboo trumpet is a cylindrical material. It can be used to demonstrate a hollow cylinder. It can be used for calculating the lateral surface area of a circle. It can be seen	1. Model of a hollow cylinder. 2. Calculating the surface area of a hollow cylinder.

				from the material how geometrical shapes can be of such importance from earlier till today.	
61	Triangle	Thlangra (winnowing tray)	1. Understanding quadrilaterals 2. Practical Geometry	The Winnowing tray is very relevant, and it can apply to the teaching-learning triangle since it is triangular.	1. Model of a triangle applicable in real life. 2. Calculating the area of a triangle.
62	Square, hemisphere, and cylinder	Thul	1. Understanding quadrilaterals 2. Practical Geometry 3. Data handling 4. Visualising solid shapes 5. Mensuration	It can be used to demonstrate squares, hemispheres, and cylinders. Also, the learner might be able to counter the volume and surface area of the hemisphere and cylinder. It is relevant in the present-day mathematics content that the learner might know and understand the beauty of mathematical figures and how	1. Model of hemisphere. 2. Calculating the capacity and lateral surface area of a hemisphere. 3. Identifying and computing cylinder, square, and their related aspects. 4. Arranging the different kinds of geometrical figures

				hemispheres, cylinders, and squares can be related.	and making a meaningful shape.
63	Cylinder, a diagonally cut circular shape	Tuium (Traditional water bottle)	1. Mensuration 2. Visualising solid shapes	It is applicable in teaching a cylinder, which is a part of mensuration, that can demonstrate the cylinder	Model of a cylinder that can be used for calculating the volume and surface area of a cylinder.
64	Circle, Sphere	Tuithawl (Water gallon)	1. Practical Geometry 2. Visualising solid shapes 3. Mensuration	This material can be useful for demonstrating the different aspects of a sphere. It represents the three-dimensional shape and can be treated as a working model. It has a circular opening for intake and a spherical body. It will be applicable in a teaching circle and sphere.	1. Calculation of curved surface area and volume 2. Combination of sphere and circle. 3. Demonstrating a circle.
65	Hallow Cylinder	Tuiumdar (A string musical instrument)	1. Visualising solid shapes 2. Mensuration	Tuiumdar is a hollow cylinder and can be used for demonstrating a hollow cylinder. It can also be used	1. Model of a cylinder. 2. Calculating the curved surface area of a cylinder.

				for computing the lateral surface area of a cylinder.	
66	Cylinder, triangle	Tuthlawh (A hoe)	1. Practical Geometry 2. Visualising solid shapes 3. Mensuration	A hoe can be used for explaining cylinders and triangles. The bamboo handle is cylindrical and can be used to calculate the volume and surface area of a cylinder. The head can also be used for explaining triangles and a curve.	Model of a cylinder, triangle, and curve.
67	Hollow Cylinder, Circle, Cylinder	Vaibel (Smoking pipe)	1. Visualising solid shapes 2. Mensuration	A smoking pipe can be used to demonstrate a cylinder. It can also be used for calculating the volume and surface area of a cylinder.	1. Model of a cylinder. 2. Model of a hollow cylinder. 3. Calculating the volume and surface area of a cylinder.
68	Circle and all related aspects	Vaihrik (A sieve)	1. Understanding quadrilaterals 2. Visualising solid shapes	It can be used for demonstrating a circle and calculating the area, circumference, and other related basic aspects of the circle. The fence can be	1. Model of a circle. 2. Calculating the area of a circle.

			3. Mensuration 4. Introduction to graphs	stretched and will be helpful in explaining the circumference of a circle and representing the circumference in a rectilinear manner.	3. Calculating the circumference of a circle.
69	Straight-Line, Right-Angle triangle, Curve	Vaithang (A trap for killing rat)	1. Understanding quadrilaterals 2. Practical Geometry	It can be used for demonstrating Straight-Line and right-angle triangles. It can also be used for calculating the area of a triangle. The string attached to the beam can make a beautiful parabolic curve with different slopes, and that can also be used for demonstrating the curves.	1. Model of a triangle 2. Calculating the area of a triangle. 3. Combining straight lines, right-angle triangles, and curves.
70	Circle, Hemisphere	Zu No (Beer cup)	1. Understanding quadrilaterals 2. Visualising solid shapes 3. Mensuration	It can be used for demonstrating circles and hemispheres. Also, it can be used for countering the volume and surface area of a hemisphere. The circular opening can be used to	1. Computing the volume, curved surface area, and whole surface area of the hemisphere.

				explain the circumference and area of the circle	2. Countering the circumference and area of a circle. 3. Combining the different kinds of geometrical figures and making a meaningful shape
71	Circle, Oval	Zubel (Traditional ceramic jar)	1. Practical Geometry 2. Visualising solid shapes 3. Mensuration	It can be used in teaching a lesson on circles and for explaining oval shapes.	1. Model of oval shape. 2. Finding the area and perimeter of a circle.

4.4.1 Discussion:

Identifying the connotation of mathematical concepts at the Class 8 level through existing cultural mathematical elements of the Mizo tribe provides an effective way to connect abstract ideas with practical experiences. The traditional activity of bamboo basket weaving in Mizo culture exemplifies significant mathematical concepts, including symmetry, geometric patterns, and measurement. The hexagonal and circular weaving patterns exemplify geometry, tessellation, and ratio, while the measurement of bamboo strips before weaving underscores proportionate reasoning (Gerdes, 1998). The construction of a typical Mizo house involves the application of spatial understanding, angles, and estimation, which can serve as a means to introduce students to the concepts of perimeter, area, and volume (Chhangte, 2019). The Mizo counting system, based on a decimal framework and shaped by linguistic nuances, serves as a gateway for examining numerical systems and arithmetic functions. Agricultural techniques, particularly jhum production, incorporate mathematical reasoning in land division, slope estimation, and yield computation, correlating with concepts such as percentages, averages, and mensuration covered in middle school curricula (MBSE, 2020).

By integrating these cultural elements into classroom instruction, learners tend to perceive mathematics not as abstract and isolated, but as intricately woven with their own community and customs (D'Ambrosio, 2001). Thus, concepts such as geometry are perceived not merely as lines and shapes, but as patterns intricately interconnected within bamboo baskets, while measurement transforms into an experiential activity rather than a solely numerical process (Supiyati & Halqi, 2020). At the Class VIII level, where students typically start to confront abstraction, such cultural context maintains engagement and enhances comprehension. Incorporating ethnomathematical components from Mizo culture has a twin function: it safeguards indigenous knowledge and enhances cognitive links between classroom mathematics and everyday life. This culturally sensitive pedagogy fosters confidence, identity, and curiosity in learners, allowing them to recognise mathematics as both a global discipline and a cultural practice pertinent to the Mizo culture.

4.5. Findings related to Objective No. 4:

Objective No.4: To develop ethnomathematical lesson plans for Class VIII students.

4.5.1 Identification of the content and topic

In designing an ethnomathematical lesson plan for Class VIII, the researcher aimed to select a topic that not only aligned with the curriculum but also offered a meaningful connection to students' cultural backgrounds and lived experiences. After reviewing the syllabus, the researcher selected a few topics that are conceptually rich and widely applicable in real-life contexts.

The researcher planned to develop an ethnomathematical lesson plan for Class VIII and sought to choose a topic that supported the curriculum while also connecting to the students' cultural backgrounds and lived experiences. The researcher examined the uses of the syllabus and selected a few topics that were inherently rich conceptually and applicable in various real-life contexts.

In crafting an ethnomathematical lesson plan for Class VIII, the researcher sought a topic that aligned with the curriculum and had a significant connection to the students' cultural backgrounds and lived experiences. After reading the syllabus outlining the topics within the curriculum, the researcher identified several topics that meaningfully engaged cultural issues, were conceptually rich, and provided real-world applicability.

Table-4.4: Content and Topic

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4.5.2 Identification of Mizo cultural aspects

Identifying Mizo cultural elements is crucial for creating ethnomathematical lesson plans that are pertinent and significant to students. Ethnomathematics emphasizes the connection between mathematics and cultural practices, recognizing that mathematical reasoning extends beyond textbooks and is embedded in the everyday activities and traditions of communities (D'Ambrosio,2001). The Mizo tribe's traditional customs, crafts, agricultural techniques, and communal rituals provide genuine mathematical experiences that may be seamlessly incorporated into classroom instruction. Traditional weaving techniques employed in the creation of clothes and mats incorporate patterns, symmetry, measurement, and counting, so inherently introducing principles of geometry, algebra, and arithmetic (Bishop, 1991). These activities offer tangible instances that enable students to investigate mathematical concepts without viewing them as abstract or unrelated to their experiences.

Besides, agricultural practices such as terraced farming, seed planting cycles, and land division provide opportunities to integrate mathematical reasoning concerning area, volume, estimation, and proportional relationships (Gerdes, 1996). Moreover, the oral storytelling traditions of the Mizo people often incorporate numerical sequences, patterns, and problem-solving situations, offering additional opportunities to merge mathematical reasoning with cultural expression (Powell & Frankenstein,1997). An essential aspect in recognising Mizo cultural aspects is the engagement of community members, especially elders, artisans, and traditional practitioners. Their expertise is essential for guaranteeing the mathematical content's accuracy, cultural relevance, and alignment with traditional practices (Frankenstein, 1995). Interacting with the community not only enriches educational material but also fortifies relationships between schools and local families, developing a sense of shared ownership of learning. It also empowers learners by recognising their cultural heritage and enhancing their self-confidence in learning and applying mathematical principles.

Integrating these cultural elements into lesson plans prompts students to perceive mathematics not as an isolated discipline but as a fundamental component of

their cultural identity. When children engage with mathematics through their own cultural traditions and experiences, it fosters a profound comprehension, stimulates inquiry, and enhances cognitive development in personally relevant ways. It also equips students to value diverse cognitive approaches and problem-solving techniques, therefore expanding their mathematical perspective.

Consequently, identifying Mizo cultural elements is crucial to formulating efficient ethnomathematical lesson plans. It ensures that mathematics education is culturally responsive, contextually relevant, and pedagogically effective. By acknowledging and integrating traditional practices into classroom instruction, educators can foster educational experiences that are academically rigorous and culturally acceptable.

4.5.3 Materials used in the Mizo day-to-day life

In the daily life of the Mizo community, a variety of objects are employed to meet practical, cultural, and social needs. These objects are designed with a comprehensive understanding of shapes, structures, and forms essential to functionality and tradition. The designs demonstrate a thorough application of geometric principles, including circles, rectangles, curves, triangles, and three-dimensional shapes, illustrating the integration of mathematical reasoning in everyday activities. The objects serve as both tools and vessels of heritage, illustrating the preservation of traditional knowledge and craftsmanship across generations (Lalrinchhani,2020).

The use of locally available resources influences the selection of items in daily life, enabling individuals to develop tools that are sustainable, efficient, and environmentally harmonious. These materials serve various purposes, including household tasks, agricultural activities, entertainment, and ritual practices. Their forms illustrate practical problem-solving and spatial awareness, frequently incorporating symmetry, proportion, and balance (Hmar, 2017). While aesthetic considerations may be present, functionality remains the primary concern, ensuring that each item fulfils the requirements of daily living and complies with cultural norms.

The materials and objects utilised in daily life by the Mizo people transcend their functional roles; they embody principles of sustainable living, cultural preservation, and mathematical comprehension. The deliberate application of shapes and structures in these objects illustrates the intrinsic relationship between everyday practices and intellectual traditions, emphasising the interplay of culture and mathematics in shaping a community's lifestyle (Hmar, 2017; Lalrinchhani, 2020; Vanlalhriatpuia, 2019).

Table 4.5: Materials used in the Mizo day-to-day life

Sl. No.	Indigenous Name	English Name	Mathematical Component
1.	Aiawt	Crab trap	Cylinder, Cone, Circle.
2.	Arbawm	Chicken basket	Square, Rectangle, Cylinder.
3.	Buhtlei	Rice stirrer	Cylinder, Curve, Oval.
4.	Chaicheh	Tongue /nipper/pincer	Straight Line, Angles and Semi-oval
5.	Chempui	Dao	Arc of a Circle, Quadrilateral, Cylinder.
6.	Chhihri	Sieve	Square, Cuboid, Rectangle.
7.	Darkhuang	Musical drum	Hemisphere, Hollow Cylinder.
8.	Favah	sickle	Curve, Cylinder.
9.	Hachhek	adze	Cylinder, Curve, Triangle.
10.	Herhsawp	Mizo stool	Cylinder, Circle, Rectangle.

11.	Hmui	A spinning wheel	Triangle, Hexagon, 60^0, perpendicular, quarter circle.
12.	Hnam	Basket strap	Rectangle, curve.
13.	Hreipui	Axe	Cylinder, Curve, Triangle.
14.	Ipte pui	Mizo traditional bag	Cuboid, curve.
15.	Kahpuk	Bamboo toy gun	Hollow Cylinder, Circle, Cylinder
16.	Kaihbu	Lattu	Cone.
17.	Kalchhet	Stilt	Hollow Cylinder and Cylindrical structure.
18.	Kho/fawng	Square base small basket	Square, circle, and cylinder
19.	Khuangpui	A common large drum	Hollow Cylinder, Circle.
20.	Khumbeu	Mizo cap	Cylinder, Curve, hexagon.
21.	Mizo in	Typical Mizo house	Rectangle, Cuboid, And Triangle
22.	Ngaawt	Fish basket	Cuboid, Circle, cylinder.
23.	Nghawngkawl	Yoke	Semicircle, curve.
24.	Ngotekherh		Straight Line, Square, Rectangle.
25.	Pai Em/ Emping	Closed-weave carrying basket	Square, Circle, straight line.
26.	Paikawng	Open-weave carrying basket	Square, Straight lines, symmetry, counting, arranging the sticks (bamboo sticks), frustum, sections of frustum.

27.	Phenglawng	Mizo bamboo flute	Hollow Cylinder, Circle.
28.	Pher	Mizo bamboo mat board	Square or Rectangle
29.	Sahdal thang	A snare for terrestrial bird	Circle, Straight Line, Curve.
30.	Saihlum	Pellet	Sphere
31.	Sa-um bur	Fermented pig fat jar	Circle, Sphere, Curve
32.	Seki no	Mithun horn drinking vessel	Circle, Cone,
33.	Suk	Pestle	Cylinder, Hemisphere.
34.	Sum	Mortar	Inverted Cone, Circle.
35.	Suvel	Cotton winding machine	Cylinder, Perpendicular, Straight Line, and Vertically Opposite Angle (V.O.A)
36.	Tap / Tapchhak	Fireplace	Square, Rectangle, Cuboid.
37.	Thlangra	Winnowing tray	Triangle
38.	Tuthlawh	A hoe	Cylinder, triangle.
39.	Vaibel	Smoking pipe	Hollow Cylinder, Circle, Cylinder
40.	Vaithang	A trap for killing rat	Straight-Line, Right-Angle triangle, Curve.
41.	Zubel	Traditional ceramic jar	Circle, Oval

4.5.4 Preparation of components of the lesson plan with pedagogical aspects

The formulation of components of an ethnomathematical lesson plan with pedagogical aspects for a Class VIII under the Mizoram Board of School Education (MBSE) necessitates a systematic approach that incorporates the indigenous

knowledge and cultural practices of the Mizo community. The lesson plan seeks to establish a significant learning environment by correlating mathematical concepts with the daily tools, artefacts, and activities essential to the Mizo people's lives. Materials such as earthen pots, bamboo tools, musical instruments, traditional agricultural implements, and household items exemplify mathematical principles, including geometry, measurement, patterns, and ratios, which can be effectively examined through contextual learning (Barton, 1996; Ernest, 1991). By incorporating these cultural factors, learners are able to relate abstract mathematical concepts to their personal experiences, thereby enhancing conceptual comprehension and promoting cognitive involvement (D'Ambrosio, 2001).

The pedagogical aspect highlights experiential learning, inquiry, and cooperative investigation, prompting students to observe, articulate, and examine the mathematical characteristics of their environment (NCTM, 2000). The utilisation of woven baskets and harvesting equipment enables learners to investigate geometry, symmetry, and surface area, whereas musical instruments such as drums and flutes provide avenues for comprehending sound waves and rhythmic patterns. Likewise, instruments such as mortars, sieves, and containers facilitate learning via measuring and estimating (Barton & Frank, 2007). Utilising indigenous resources guarantees cultural significance, thereby reinforcing learners' identities and fostering inclusivity and reverence for local traditions (Ascher, 1991). The lesson plan framework comprises objectives, instructional strategies, learning activities, and evaluation procedures meticulously crafted to align with academic standards and cultural settings (Skovsmose,1994).

In addition, it prompts educators to assume the role of facilitators, assisting students in linking mathematical reasoning to practical applications, so fostering profound learning and critical analysis (Bishop, 1988). The meticulous development of these instructional components, with careful pedagogical attention, enhances the educational experience by presenting mathematics as a dynamic discipline intertwined with the cultural heritage of the Mizo community.

4.5.5 Development of ethnomathematical lesson plans

The development of ethnomathematical lesson plans necessitated the integration of cultural practices with formal mathematical principles, enabling students to relate everyday experiences to academic learning. Ethnomathematics asserts that mathematics is not just universal in structure but is profoundly influenced by cultural practices and epistemologies (Rosa & Orey, 2016). For the Mizo, whose culture is characterised by weaving, bamboo craftsmanship, agriculture, music, and communal customs, lesson plans based on ethnomathematics offer an opportunity to contextualise abstract concepts in significant ways. For instance, Bamboo basket making, which is integral to Mizo livelihood, inherently encompasses measuring, proportion, and spatial thinking, giving it an exemplary basis for culturally responsive mathematics instruction. The architectural design of the traditional Mizo home exemplifies practical applications of measurement, area, perimeter, and the Pythagorean theorem in maintaining structural stability and equilibrium.

Ethnomathematical teachings present mathematical principles by initially exploring cultural practices—such as weaving patterns, traditional games, or communal feasts—and subsequently connecting them to academic mathematics. This method diminishes estrangement from abstract learning, enhances cultural pride, and cultivates motivation by demonstrating that mathematics is embedded in students' daily cultural experiences. The lesson plans must be structured to foster critical thinking, rather than just provide cultural experience. Students should participate in project-based learning activities, such as developing weaving patterns based on geometric principles, constructing scale models, or conducting statistical analyses of data related to traditional Mizo festivals. This methodology corresponds with the constructivist theory of learning, wherein students acquire information via experiential learning and social interaction (Vygotsky, 1978). The last and most crucial phase is execution with discernment. The growth process depends on collaboration with elders, craftspeople, and community members, who possess traditional knowledge. Their involvement guarantees authenticity and averts shallow or tokenistic utilisation of cultural components. This method significantly aids in the decolonisation

of education by seeing indigenous knowledge systems as viable mathematical sources, hence contesting the supremacy of Eurocentric paradigms (Rosa & Orey,2016).

In summary, ethnomathematical lesson plans seek to integrate cultural practices—such as weaving, bamboo crafts, agriculture, and community traditions—with formal mathematics, employing constructivist and culturally responsive pedagogical approaches. These instructional modules not only augment mathematics comprehension but also foster cultural pride and identity. Integrating indigenous knowledge into the classroom fosters inclusive and contextually relevant education that connects culture and mathematics.

4.5.6 Validation of ethnomathematical lesson plans

Validating ethnomathematical lesson plans is a crucial step to confirm that the developed instructional materials are effective, reliable, and consistent with cultural and mathematical learning objectives. Ethnomathematical lesson plans incorporate cultural practices, indigenous knowledge, and mathematical concepts, necessitating evaluation to ascertain their relevance, appropriateness, and pedagogical efficacy. The validation process begins with the development of a systematic ethnomathematical lesson plan that evaluates various aspects, including content validity, cultural relevance, pedagogical appropriateness, clarity of objectives, and practicality for classroom implementation.

Experts in mathematics education, curriculum design, language, and ethnomathematics are engaged to review the lesson plans. Their feedback helps determine whether the lessons truly reflect cultural contexts, connect meaningfully with mathematical concepts, and cater to the cognitive level of Class 8 learners. The responses are analyzed to identify the strengths of the lesson plans, as well as areas that need modification or refinement. For instance, an expert validates that a lesson on geometric patterns in traditional weaving effectively links cultural artifacts with mathematical symmetry but may suggest simplifying the language to suit students' comprehension levels.

Also, the validation helps to determine whether the lesson plans foster critical thinking, cultural appreciation, and mathematical problem-solving among students. By systematically validating the lesson plans through such research procedure, educators and researchers can ensure that the instructional materials not only maintain academic rigor but also respect cultural authenticity. Ultimately, this process guarantees that the ethnomathematical lesson plans for Class VIII are both pedagogically sound and culturally meaningful, making them suitable for classroom practice and contributing effectively to the goals of inclusive and context-based mathematics education

4.5.7 Pilot testing of ethnomathematical lesson plans

Pilot testing is a crucial stage in educational research, enabling the researcher to evaluate the feasibility, clarity, and effectiveness of newly developed instructional materials prior to comprehensive implementation. This study involved a pilot test of ethnomathematical lesson plans at a school governed by the Mizoram Board of School Education (MBSE) to assess the feasibility of merging indigenous knowledge with formal mathematical principles. Ethnomathematics underscores the connection between culture and mathematics, illustrating how mathematical concepts are integrated into traditional activities, crafts, and everyday experiences (D'Ambrosio, 1985; Rosa & Orey, 2016). Through the implementation of the pilot lesson plans in a real classroom setting, the researcher was able to assess students' responses, engagement, and comprehension levels, alongside teachers' preparedness and the alignment of the activities with the MBSE curriculum. The school-based pilot study produced significant insights regarding class pacing, instructional clarity, teaching resources, and assessment strategies. Also, it highlighted practical challenges, including time management, resource accessibility, and disparities in students' existing knowledge. The implementation of the pilot study in an actual classroom confirmed the reliability and validity of the lesson plans as educational instruments (Cohen, Manion & Morrison, 2018). This also allowed the researcher to enhance and modify the instructional strategies to more effectively align with the cultural and educational environment of Mizo learners. This iterative process uncovered both the strengths and limitations of the lesson plans, resulting in enhancements that improved their relevance

and effectiveness. The pilot testing ultimately validated the effectiveness of ethnomathematical approaches in enhancing mathematical comprehension while continuously preserving indigenous knowledge and practices in educational settings (Bishop, 1991).

4.5.8 Development of final ethnomathematical lesson plans

The development of final ethnomathematical lesson plans required a systematic approach that integrated pedagogical principles with indigenous cultural knowledge to ensure relevance and efficacy in mathematics education. Ethnomathematics emphasises the incorporation of cultural practices into mathematical education, enabling students to relate abstract concepts to real-life experiences embedded in their traditions (D'Ambrosio, 2001).

In the Mizo context, this approach started with the identification of cultural artefacts, practices, and knowledge systems that include intrinsic mathematical principles, including bamboo basket weaving, traditional house construction, agricultural measurement, and community games. These activities embody mathematical concepts, including symmetry, geometry, measurement, ratios, and problem-solving techniques inherent in cultural expressions (Rosa & Orey, 2016). Once identifying these practices, lesson objectives were formulated in accordance with the school curriculum, ensuring that cultural aspects were integrated as significant contexts for comprehending the mandated mathematical ideas. The development of the final lesson plans also required validation. Initial drafts were shared with experts in mathematics education, curriculum design, language experts, cultural experts, and classroom teachers to evaluate their feasibility, accuracy, and cultural authenticity. Feedback from these stakeholders helped refine the plans by balancing cultural richness with curricular requirements.

The integration method employed a constructivist approach, wherein students actively participated in practical cultural tasks while concurrently expressing the foundational mathematical concepts. This contextualisation improved student involvement, rendered abstract concepts more concrete, and diminished the alienation students frequently experience about mathematics (Bishop,1991). A vital phase in the

development involved the organisation of pedagogical approaches and evaluation techniques. The lesson plans employed activity-based and inquiry-oriented pedagogical approaches, allowing students to investigate, contemplate, and extrapolate mathematical concepts from cultural tasks. For instance, in the analysis of traditional rice terrace farming, students explored measuring, volume, and proportion, so linking agricultural knowledge with mathematical thinking. Assessments were created to measure both procedural fluency and students' capacity to connect cultural settings with mathematical concepts, thus promoting higher-order thinking abilities (Adam, Alangui, & Barton, 2003). This culturally responsive methodology frames mathematics as a dynamic field that aligns with learners' identities, enhancing its significance and accessibility.

In summary, the creation of the final ethnomathematical lesson plans entailed a collaborative and iterative approach that honoured indigenous customs while upholding academic rigour. The incorporation of Mizo cultural components such as weaving, agriculture, and traditional sports into classroom instruction provides learners with a dual comprehension of mathematics: both as a universal study and as a cultural practice. By contextualising mathematics within local reality, these lesson designs not only improved educational achievements but also reinforced cultural pride and identity among pupils. This method illustrated the potential of ethnomathematics to connect formal education with indigenous knowledge, fostering a more inclusive and comprehensive learning experience (Rosa & Orey, 2016; Barton, 1996).

The final version of the developed ethnomathematical lesson plans is attached in Appendix II.

4.6 Findings related to Objective No.5:

Objective No.5 Effect of ethnomathematical teaching strategies on mathematics achievements among Class VIII students

Table: 4.6

Results of Mixed-Type Group Test of Intelligence

School	Section	Group	N	Mean	*t-score limit	Intelligence level
Helen Lowry School	A	Control	45	25.62	37-43	Dull Average Intelligence
	B	Experimental	45	23.51	37-43	

***t-score limit has been taken from the manual of the test.**

4.6.1 Descriptive Statistics of Helen Lowry School for the test of Effect of ethnomathematical teaching strategies on mathematics achievements

Table:4.7

Descriptive Statistics of Helen Lowry School

School	Section	Group	N	Mean	S.D.
Helen Lowry School	A	Control	45	16.04	3.47
	B	Experimental	45	17.40	3.49

Table 4.7 indicates that there were 45 students in the control group, who received teaching using standard teaching methods, and 45 students in the experimental group, who were instructed using ethnomathematical teaching strategies. Table 4.5.1 clearly indicates that the mean score of the post-test for the group taught by traditional methods was 16.04, with a standard deviation of 3.47. In contrast, the group taught by applying ethnomathematical teaching strategies achieved a mean score of 17.40, with a standard deviation of 3.49.

4.6.2 Testing the Assumption of independence of treatment and the covariate (pre-test)

Before implementing the Analysis of Covariance, it is essential to fulfil a fundamental assumption: there must be no significant interaction between the treatment and the covariate (pre-test). Therefore, ANOVA and the t-test can also be utilised independently to analyse the interaction. Here, ANOVA was employed for the testing.

Table 4.8

Independence of treatment and the covariate (pre-test) for the data of Helen Lowry School for the test of Test of Mathematics Achievement

Test	Group	N	Mean	S.D.	F value	P value	Decision
Test of Mathematics Achievement	Control	45	13.95	4.06	**3.09**	**0.08**	Not significant at 0.05 level of significance
	Experimental	45	12.26	2.83			

Interpretation

Table 4.8 indicates that the F value is 3.09 with p = 0.08>0.05, which is non-significant at the 0.05 level of significance. Thus, it can be observed that the treatment and the covariate impact are independent. Therefore, the assumption for the ANCOVA for the sample School data was satisfied.

4.6.3 Testing the Assumption of Homogeneity of Regression Slopes

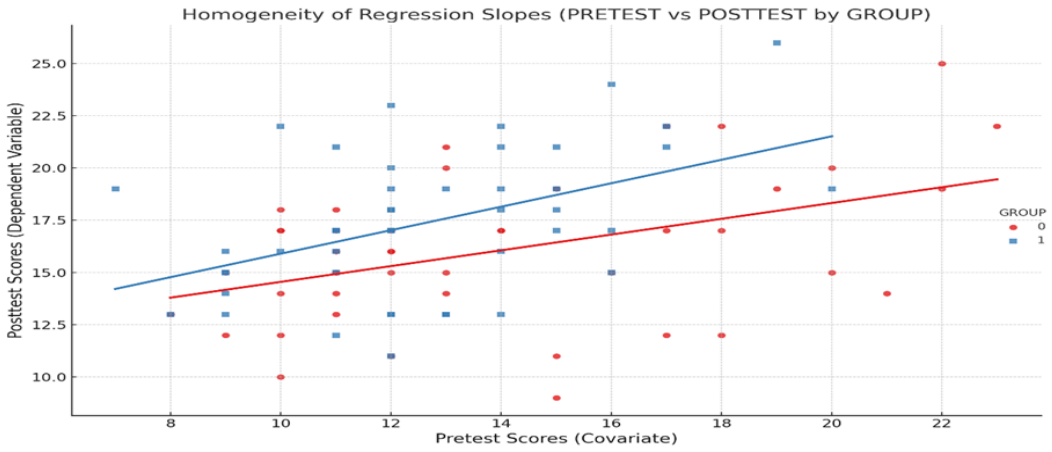
This is another assumption that must be satisfied for the use of ANCOVA. This assumption elucidates the interaction between the covariate (pre-test) and the treatment. The results of the homogeneity of regression slopes tests were determined to be non-significant. The calculated F value is 0.81 with p = 0.37>0.05. Thus, it verifies the applicability of ANCOVA to these data.

Table: 4.9

Interaction between covariate (pre-test) and treatment

Test	Group	N	F Value	P value	Decision
Test of Mathematics Achievement	Control	45	0.81	0.37	Not significant at 0.05 level of significance
	Experimental	45			

Fig 4.1: Regression slope



The graph above depicts the correlation between Pretest scores (covariate) and Post-test scores (dependent variable) in the two groups. Each group possesses a distinct regression line that illustrates the variation in post-test performance corresponding to increases in pretest scores. The assumption of homogeneity of regression slopes in ANCOVA requires that these regression lines remain approximately parallel. Parallel slopes signify that the influence of the covariate (Pre-test) on the dependent variable (post-test) remains uniform across all groups, indicating the absence of an interaction effect between group affiliation and pretest scores.

This is a crucial criterion for ANCOVA, since it guarantees an equitable comparison of group means subsequent to the adjustment for pretest disparities. Significantly divergent slopes would indicate that group membership alters the link between pretest and post-test results, thus contravening the assumption. The graph substantiates the application of ANCOVA in this dataset.

4.6.4 Testing the Assumption for the homogeneity of variance.

The homogeneity of variance is another essential assumption that underpins the validity of parametric tests, including the t-test, ANOVA, and ANCOVA. This assumption evaluates if each dependent variable exhibits comparable variation across the two groups, indicating that the error variance is identical for both groups. ***Levene's test*** is the most used and reliable method for assessing homogeneity of variance. Thus, Levene's test was employed to evaluate the homogeneity of variance. If Levene's test is not significant, it can be concluded that the assumption is true.

Table-4.10

Levene's Test of Equality of Error Variance

Post-test	F	df1	df2	p-value	Decision
Test of Mathematics Achievement	.002	1	88	0.96	Not-significant at 0.05 level of significance

Table 4.10 indicates that the assumption of homogeneity of variance between the two groups is satisfied, since Levene's test yielded a non-significant value, p = .096> .05. Therefore, the assumption of homogeneity of variance is satisfied. ***So, all assumptions have been satisfied; thus, it can be determined that ANCOVA applies to the data from Helen Lowry School for the Test of Mathematics Achievement.***

Thus, ANCOVA has been employed to evaluate the effect of ethnomathematical teaching strategies on the mathematical achievements of Class VIII students.

4.6.5 ANCOVA showing pre-test and post-test scores of control and experimental group of Helen Lowry School on Test of Mathematics Achievement (TMA).

Table:4.11

Group	Pre-test mean	Post-test mean	Source of variation	df	Sum of squares	Mean sum of squares	$F_{y.x}$	p-value
Control	13.95	16.04	Among	1	80.247	80.247	**8.103**	**0.006**
Experimental	12.66	17.4	Within	87	861.645	9.904		

Table 4.11 indicates that the Analysis of Covariance was significant, $F(1, 87) = 8.103$, $p < 0.005$ (refer to table 4.11). The calculated value Fy.x (8.103) for the differences in the post-test scores was determined to be significant at the 0.05 level of significance with degrees of freedom = (1, 87). Hence, the null hypothesis was rejected, which means that there is a significant difference between the experimental and control groups with respect to the Test of Mathematics Achievement (TMA). Also, the mean score of the post-test for the Test of Mathematics Achievement (TMA) in the experimental group (M = 17.4) is considerably greater than that of the control group (M = 16.04) at Helen Lowry School. Therefore, it is evident that ethnomathematical teaching strategies have significantly contributed to mathematics achievement among class VIII students.

4.6.6 Experiences of Students Regarding the Ethnomathematical Lesson Plan

The primary objective of this study is to test the effectiveness of the ethnomathematical lesson plan through a quasi-experimental design. The researcher developed a Semi-Structured Interview Schedule (APPENDIX - IV) to obtain information about the experiences of students instructed with the developed lesson plan in the experimental group during the research experiment. Upon concluding the post-test in both groups of the school, the Semi-Structured Interview Schedule was administered only to the experimental group. It has ten open-ended questions that focus on the essential elements of the lesson plan and were utilized to gather students' experiences about the lesson plan.

4.6.6.1 Analysis and Discussion of Students Experiences

In the Semi-Structured Interview Schedule, Q1, Q5, and Q8 pertain to the first category; Q2 and Q4 correspond to the second category; Q6, Q7, and Q10 relate to the third category; and Q3 and Q9 are associated with the fourth category. A total of 45 completed Semi-Structured Interview Schedules were received from the students.

Table 4.12: Experiences of Students

Sl. No.	**Type of Experiences**	**Question Number**
1	Experiences related to comprehensive learning through the lesson plan	**Q1, Q5, Q8**
2	Experiences related to the lesson plan activities.	**Q2, Q4**
3	Experiences related to the acquisition of mathematical knowledge with the help of the lesson plan	**Q6, Q7, Q10**
4	Experiences associated with learning through textbooks and the distinctions perceived when utilising the lesson plan	**Q3, Q9**

4.6.6.2 Experiences related to comprehensive learning through the lesson plan

The experiences of most of the students with the lesson plan are significantly encouraging, saying that the lesson plan is valuable in its application, material presentation, activities, and mathematical education. Students have generally indicated that they find the Teaching Learning Materials (TLM) engaging and practical, enabling them to apply these resources in real-life contexts. Students have conveyed their experiences with the acquisition of other subjects and associated knowledge through this type of lesson plan. The activities included in the lesson plan for enhancing mathematical reasoning and their application within the units were deemed fascinating and beneficial for comprehending the subjects. Several students have expressed appreciation for the learning objectives, as these enabled them to properly understand the concepts to be covered in the specific unit.

Their experiences clearly show that they appreciated learning mathematics through a well-structured lesson plan, which ensured its efficacy and utility. These experiences confirm the quantitative evidence about the effectiveness of the lesson plan, and their positive learning experiences in mathematics are reflected in the Test of Mathematics Achievement (TMA).

4.6.6.3 Experiences related to the lesson plan activities.

The majority of students have indicated that the activities conducted in each unit of the lesson plan were interesting and interactive. Students have indicated that several activities in the sections on graphs, visualizing solid shapes, data handling, and mensuration were exciting and applicable to everyday life.

4.6.6.4 Experiences related to the acquisition of mathematical knowledge with the help of the lesson plan

Mostly, students have reported that learning mathematics with the help of a lesson plan was interesting and helpful in understanding the various concepts. The majority of students have shown a keen interest in learning other subjects with the help of a similar kind of lesson plan. Along with this, students have found the sequence of

the concepts in the lesson plan also quite supportive in the learning of difficult concepts like mensuration, visualizing solid shapes. Almost more than 80% students have reported this experience of better and suitable learning of mathematics with the help of the lesson plan.

4.6.6.5 Experiences associated with learning through textbooks and the distinctions perceived when utilising the lesson plan

Students have indicated that their learning experience with the lesson plan differs from the textbook. Students indicate that the Mizo cultural materials provided in the lesson enhance their comprehension, and they appreciate the learning materials. Most students favoured units such as graphs, data handling, mensuration, and the visualization of solid shapes. The primary distinction reported by students between the textbook and lesson plan was the use of Mizo cultural materials in each class.

Chapter-V

Summary, Findings and Conclusions

5.1 Summary of the Study

5.1.1 Need and Importance of the Study

Mathematics is often regarded as a universal language, yet its teaching and learning are shaped by cultural contexts (D'Ambrosio, 2001). Among the Mizo tribe of Northeast India, rich mathematical knowledge is reflected in traditional practices such as weaving, basket-making, land measurement, and agricultural activities. These indigenous forms of mathematical reasoning, however, remain largely unacknowledged in formal education. It is needed to solve Mizo students' cultural disconnect in mathematics education and contribute to ethnomathematics research and policy.

This study is important to bridge the gap between indigenous knowledge and formal mathematics education through an ethnomathematical approach. By documenting and integrating cultural practices into mathematics instruction, the research aligns with the National Education Policy (NCERT, 2005; NEP, 2020: Ch-1, sec-4, clause 4.6), which emphasises contextually relevant and inclusive learning. Furthermore, it contributes to decolonising the mathematics curriculum by recognising the epistemological value of indigenous traditions (De Freitas & Sinclair, 2014; Orey & Rosa, 2020). The study holds significance not only for enhancing mathematical understanding and motivation among Mizo learners but also for preserving cultural heritage and identity. Ultimately, it offers valuable implications for curriculum design, teacher education, and culturally responsive pedagogy in Mizoram.

5.1.2 Statement of the Research Problem

'Mathematics Learning among Mizo Tribe: An Ethnomathematical Study'.

5.1.3 Research Questions

1. What kind of mathematical elements does Mizo culture have?

2. How can these elements be utilized to enhance and promote mathematics learning among students of different grades?
3. Which mathematical concepts at the elementary level would be applicable to the traditional activities of the Mizo tribe, and how would that be applicable in the teaching and learning process of mathematics? (As an Ethnomathematics approach)

5.1.4 Objectives of the Study

1. To study the mathematical elements which exist in the culture of the Mizo tribe.
2. To identify the different mathematical activities embedded among different cultural materials of the Mizo tribe.
3. To identify the connotation of mathematical concepts at the Class VIII level with existing cultural mathematical elements of the Mizo tribe.
4. To develop ethnomathematical lesson plans for Class VIII students.
5. To study the effect of ethnomathematical teaching strategies on mathematics achievements among Class VIII students.

5.1.5 Hypotheses of the Study

Research Hypotheses

H_1: An Ethnomathematical Lesson Plan can have a significant effect on the mathematics achievement of Class VIII students.

Null Hypotheses

H_0: There is no significant effect of the ethnomathematical lesson plan on the mathematics achievement of Class VIII students.

5.1.6 Variables of the Study

Independent Variable

The present study involves one independent variable. The teaching method, i.e., ethnomathematical teaching strategies and traditional teaching methods, served as an independent variable.

Dependent Variable

The dependent variable, which served as the criterion for evaluating the treatment effect, was mathematical achievement. The purpose of obtaining the variables was to determine the alteration in students' mathematical achievement results from the treatments.

5.1.7 Methodology of the Study

The methodology of the present study will be mixed methods. The present study will be done in two phases.

1. In the first phase of the study, an **exploratory survey** was done to identify the elements of mathematics and its different aspects existing in the culture of the Mizo tribes. This phase included the interview of some of the identified indigenous Mizo people and educated Mizo professionals in research and teaching. Along with this, an interview schedule was used to observe the same.

2. In phase two, a **quasi-experimental** (pre-test non-equivalent control group design) technique was used to study the effectiveness of the identified mathematical elements of Mizo culture on the mathematics achievement of Class VIII students.

Groups	Pre-Test		Treatment	Post-Test
A	O1	→	C	O2
B	O3	→	X	O4

Where: A= Control Group, B= Experimental group, C= Conventional Method of Teaching, X= Ethnomathematical Lesson plan-based teaching strategies Approach, O1& O3= Pre-test, and O2 & O4= Post-test.

5.1.8 Population

Phase-I

The indigenous people of the Mizo Tribe of Mizoram, who are involved in their traditional activities (*like making a square base small basket, bamboo stool, winnowing tray, crab trap, and Mizo bow*) and educated professionals, especially in research and teaching from Mizoram, were the population for the first phase of the study.

Phase-II

The research population comprised class VIII students enrolled in the Mizoram Board of School Education (MBSE) in Aizawl City for the academic year 2024-2025.

5.1.9 Sample

Phase-I

For the first phase, five (5) indigenous groups (who are involved in their traditional activities) of the Mizo Tribe from each District of Mizoram were selected as a sample with the help of a purposive sampling technique. Also, the researcher visited the Mizoram State Museum for clarification of the English names of the indigenous materials. Educated professionals in research and teaching from Mizoram University were selected using a purposive sampling technique.

Phase-II

For the second phase, the researcher has taken a School, where two sections (control and experimental) are available. Since the prepared lesson plan is based on the dimensions of ethnomathematics and to minimize the interaction effect during the experiment, two different sections (A and B) from one school, having the same learning environment and the same standards, have been taken.

Due to practical challenges, unavailability, and lack of cooperation from schools in randomising classrooms, the researcher was forced to execute this experiment only in those schools that were cooperative. Consequently, purposive sampling was employed to choose the school. The study sample comprised 90 students from sections A and B of the school in Aizawl. All of these students were registered in class VIII for the 2024-2025 academic session. The school prohibited the random

assignment of students into groups. Thus, the researcher was compelled to experiment on an intact group present in the schools. Using Helen Lowry School under MBSE as a sample, Section B has been designated as the experimental group, while Section A serves as the control group.

Table-5.1: Distribution of the sample

School	Section	Group	N
Helen Lowry School	A	Control	45
	B	Experimental	45

5.1.10 Instruments/Tools used in the Study

Phase-I

Interview Schedule

A self-constructed interview schedule was used for a comprehensive study on the mathematical aspects inherent in the culture of the Mizo tribe, accompanied by methodical observational procedures. The interview schedule encompasses two components: Biographic Information and Mizo cultural elements.

Phase-II

Mixed Group Test of Intelligence (MGTI)

The current test was developed by Dr. P.N. Mehrotra and comprises two components: verbal and non-verbal examinations. Each component contains fifty items structured in an omnibus selected format, and this assessment is suitably referred to as a mixed intelligence test. This was utilised to assess the IQ of pupils aged 12 to 17 years. Consequently, the test was determined to be appropriate for eighth-grade students. The split-half, test-retest, and Kuder-Richardson reliability coefficients of the complete test were determined to be 0.88, 0.86, and 0.85, respectively.

Test of Mathematics Achievement

The Test of Mathematics Achievement (TMA) was developed to measure the mathematical proficiency of eighth-grade students. The achievement of students is influenced by the implementation of ethnomathematical teaching strategies through the lesson plan; hence, precautions were taken to construct the items to encompass the content selected for the development of the lesson plan. The test has 30 multiple-choice questions. One mark is awarded for each correct answer and zero marks for each incorrect response. The test has a maximum score of 30 and a minimum score of 0. The split-half reliability of the test was determined to be 0.76, while the Kuder-Richardson 20 reliability was 0.79.

Ethnomathematical Lesson Plan

Preparation of an Ethnomathematical lesson plan is done in the following stages

1. Identification of the content and topic
2. Identification of Mizo cultural aspects
3. Materials used in the Mizo day-to-day life
4. Preparation of components of the lesson plan with pedagogical aspects
5. Development of ethnomathematical lesson plans
6. Validation of ethnomathematical lesson plans
7. Pilot testing of ethnomathematical lesson plans
8. Development of final ethnomathematical lesson plans

Semi-Structured Interview Schedule

The semi-structured interview schedule has 10 open-ended questions, all of which highlight the key components of teaching strategies of the lesson plans, including activities, assessments, and experiences associated with learning mathematics through an ethnomathematical lesson plan. After concluding the experiment, a semi-structured interview schedule was employed to gather the mathematics learning experiences of the experimental group students. The questions in the semi-structured interview schedule have been categorized into four distinct

groups relating to the learning associated with the teaching strategies outlined in the lesson plans

5.1.11 Data Analysis

Phase-I

Qualitative data analysis was employed to analyse the evidence from the first phase of the study, using the Miles & Huberman (1994) model of qualitative data analysis.

Phase-II

Descriptive statistics, including mean, median, mode, and standard deviation, along with inferential statistics such as ANCOVA (Analysis of Covariance), were employed for data analysis and deriving significant inferences relevant to the study's objective. Data coding and entry were performed using Microsoft Excel, while further data analysis was conducted using SPSS version 27.

5.2 Findings of the Study

This section provides a summary of the findings obtained from the analysis and interpretation of the data. The main findings of the study, categorised by objectives and aligned with the hypotheses, are as follows:

Findings related to objective 1:

Objective No.1: To study the mathematical elements which exist in the culture of the Mizo tribe.

The objectives aim to study the 71 mathematical elements that exist in the culture of the Mizo tribe. The diverse range of Mizo indigenous materials reflects the community's rich cultural heritage and its strong bond with the environment. These traditional artefacts, comprising household utilities, agricultural equipment, musical instruments, and storage vessels, highlight the integration of practical knowledge and creativity in Mizo daily life. Artefacts such as Aiawt (crab trap), Arbawm (chicken

basket), and Ngaawt (fish basket) exemplify sustainable practices of food collection and animal rearing rooted in local ecology. Agricultural implements such as the Favah (sickle), Tuthlawh (hoe), and Suk (pestle) exemplify indigenous knowledge systems that support livelihood practices. Domestic tools, including the Baibel (an earthen pot), Buhherkhawl (a wooden mortar), and Maufian (a bamboo spoon), exemplify the community's dependence on natural resources like bamboo, wood, and clay, highlighting their environmentally sustainable habits. Artistic and recreational components such as the Phenglawng (bamboo flute), Tawtawrawt (bamboo trumpet), and Khuangpui (large drum) underscore the cultural importance of music and oral traditions in fostering communal cohesiveness. Moreover, elements such as the Mizo (typical Mizo house) and Tapchhak (fireplace) exemplify architectural acumen and domestic arrangement. These materials collectively represent mathematical, ecological, and cultural aspects, making them essential for ethnomathematical research and pedagogical incorporation, thus connecting traditional techniques with modern learning.

Findings related to objective 2:

Objective No.2: To identify the different mathematical activities embedded among different cultural materials of the Mizo tribe.

The study's objectives emphasise the significance of recognising mathematical principles inherent in the traditional artefacts of the Mizo tribe. A wide variety of traditional tools, domestic objects, musical instruments, and agricultural implements demonstrates profound mathematical understanding, particularly in geometry, measurement, and symmetry. Common items such as baskets, pots, stools, plates, spoons, and traps exemplify the application of geometric forms, including cylinders, cones, spheres, cuboids, and hemispheres, as well as the concepts of volume, capacity, and proportion. Baskets and traps exemplify the use of cylindrical and conical structures, whereas cooking utensils and jars frequently integrate circular and hemispherical forms to optimise space and functionality.

Musical instruments like drums, trumpets, and flutes incorporate cylindrical and conical shapes to generate sound, so connecting mathematics with acoustics. Weaving, spinning, and textile production exemplify patterns, symmetry, and measurement in design, whereas implements such as sickles, hoes, and axes demonstrate applied geometry through their triangular and curved configurations. Children's toys, such as spinning tops, bamboo guns, and stilts, offer amusement while illustrating principles of balance, rotation, and motion based on mathematical reasoning. These cultural customs demonstrate the community's instinctive utilisation of mathematics in their daily activities without formal education. Utensils like measuring bowls, pestles, mortars, and sieves demonstrate practical understanding of dimensions, capacity, and proportions, whereas traps for avian, aquatic, and rodent species exemplify problem-solving via geometric design and mechanical equilibrium. Housing and furniture exemplify mathematical principles by employing cuboidal, triangular, and cylindrical shapes for stability and proportion.

These objectives emphasise that mathematics is fundamentally embedded in the traditions of the Mizo people. Their cultural artefacts fulfil functional and aesthetic functions while also embodying inherent mathematical concepts. Identifying these characteristics can enhance ethnomathematical pedagogies, rendering education more significant by linking classroom concepts to real-life situations.

Findings related to objective 3:

Objective No.3: To identify the connotation of mathematical concepts at the Class VIII level with existing cultural mathematical elements of the Mizo tribe.

The third objective of the study aims to investigate the connotation of mathematical concepts at the Class VIII level by including cultural mathematical aspects from the Mizo tribe. The investigation demonstrated that the traditional artefacts and practices of the Mizo culture embody a diverse array of mathematical concepts, especially in the areas of geometry and mensuration. Cultural artefacts, including baskets, pots, drums, and tools, exemplify geometric shapes such as cylinders, cones, spheres, cuboids, hemispheres, and ovals, which correspond directly

with the mathematical concepts presented in the educational curriculum. Cylindrical objects elucidate surface area and volume, conical shapes facilitate an understanding of cone qualities, while round and hemispherical objects illustrate circumference, area, and three-dimensional visualization.

The findings show that these cultural artefacts offer practical frameworks for intricate mathematical concepts, making abstract mathematics more easily accessible and significant. Linking classroom instruction with concrete cultural artefacts enhances students' ability to visualise forms, measure dimensions, and calculate perimeter, area, and volume. The objects provide possibilities to illustrate symmetry, angles, parabolic curves, and line intersections, so connecting practical experiences with theoretical concepts. The cultural context enhances understanding and cultivates cultural pride by emphasising the mathematical knowledge inherent in indigenous activities.

The objective emphasises the educational significance of ethnomathematics in connecting local culture with formal education. The integration of traditional artefacts as instructional tools increases experiential learning, engages students through familiar situations, and augments the curriculum with cultural significance. The connotation of mathematical concepts, grounded in the lived experiences of the Mizo tribe, enhances comprehension, improves retention, and facilitates meaningful application of mathematics in everyday life

Findings related to objective 4:

Objective No.4: To develop ethnomathematical lesson plans for Class VIII students.

The fourth objective of this research focuses on the systematic development of an Ethnomathematical lesson plan. The approach is systematic and consists of eight separate, sequential stages to ensure educational integrity and cultural authenticity.

The initial phase comprises a fundamental identification of the mathematical content and relevant Mizo cultural elements, ensuring an intrinsic connection between

the curriculum and local tradition. This is followed by the collection of resources from Mizo daily life to provide concrete, relatable educational tools. The core activity is the preparation and development of the lesson plan's components, carefully integrating suitable pedagogical strategies.

The produced lesson plans are not deemed final upon their initial development. They undergo a severe validation process to verify their quality and accuracy, followed by practical pilot testing to measure their effectiveness in an actual classroom setting. The knowledge and information obtained from these evaluation stages inform the next step: refining and developing the validated ethnomathematical lesson modules. This comprehensive approach, which involves moving from design to validation and refinement, ensures that the finished product remains educationally valid and a significant tool for integrating Mizo culture with mathematics education.

Findings related to objective 5:

Objective No.5: To study the effect of ethnomathematical teaching strategies on mathematics achievements among Class VIII students.

It is found that there exists a significant difference between the experimental and control groups with respect to the Test of Mathematics Achievement (TMA). The experimental group has a higher mean relative to the control group for the post-test results of students' mathematical achievement. Ethnomathematical teaching strategies have significantly enhanced students' mathematical achievement. The results of the Analysis of Covariance indicate significance that $F(1, 87) = 8.103$, and $p(0.006) < 0.05$.

5.3 Conclusion of the Study

Based on the findings of Objective 1, it can be concluded that several traditional materials from the Mizo culture exist and are used among community members. They are unique in their styles and methods of use within the Mizo culture. Based on the findings related to objective-2, it can be concluded that several mathematical concepts were integrated into the traditional activities of the Mizo culture, including tools, baskets, and pots. This indicates that if different mathematical

concepts are integrated within a singular community, such as the Mizo, then in a nation like India, which has significant cultural and communal variety, similar investigations are necessary and can be conducted for improved generalizations Findings for objective 3 directed to conclude that the connotation of mathematical concepts at the Class VIII level with existing cultural mathematical elements of the Mizo tribe were identified. The connection between mathematics and existing cultural materials was considered satisfactory, and Mizo cultural materials can serve as examples, models, and demonstrations of mathematical concepts. The Mizo people unknowingly utilize mathematical skills in their daily lives, often unaware of their significance. The transfer of such skills to educational institutions is likely to help with instruction and comprehension of mathematics. Consequently, the skills of the people who utilise mathematics within their cultures, although without formal training, may enhance the educational achievements of learners in the classroom. Based on the findings related to Objective 4, it is evident that the ethnomathematics lesson plan can be developed by using traditional Mizo cultural materials as learning tools or TLM in the classroom for Class VIII students. Based on findings related to objective 5, it has been concluded that ethnomathematical teaching strategies are effective in enhancing mathematics achievement among Class VIII students as compared to the conventional teaching method.

The National Curriculum Framework (NCF, 2005) advocates for developing children's mathematical skills and offers numerous recommendations to address challenges, including the necessity for children to comprehend the significance of mathematics in everyday life. This study also incorporates the same ideas and promotes the multicultural and ethnomathematical components of mathematics education within the Mizo community. The researcher researched teaching and learning mathematics through traditional practices of the Mizo culture. Likewise, numerous community and local organisations engage in cultural activities that may be beneficial for instructing mathematics and other related disciplines. Our nation possesses a variety of cultural and tribal communities. This is necessary for transferring these diversities and activities from society to the classroom and adapting them for educational purposes through study. By considering the students'

shared experiences, individual learning styles, beliefs, and diversities, educators and the school environment can improve the teaching and learning of mathematics and other scientific disciplines.

5.4 Educational Implications of the Study

The results of this study suggest several educational implications for students, teachers, teacher educators, and curriculum developers. They are as follows:

- Mathematical elements that exist in the Mizo tribe can be utilised for the teaching and learning of mathematics, serving as teaching-learning materials for educators, students, and curriculum creators.

- The mathematical concepts embedded in the traditional practices of the Mizo community can serve as examples, explanations, elaborations, and solutions for mathematical problems at different levels of mathematics.

- The connotation of a mathematical concept with cultural elements can make students' perspectives more interesting.

- The developed ethnomathematical lesson plan can be provided/distributed to educators as instructional resources for teaching mathematical concepts in quadrilaterals, geometry, mensuration, etc.

- The developed lesson plan changes the dimension of mathematics, highlighting that it is applicable in real-life situations.

- Ethnomathematical teaching strategies may serve as an improved alternative to conventional methods for improving students' mathematics achievement.

- This study has direct implications for teacher education programs. In mathematics education, efficient instructional strategies are essential; therefore, teacher educators must train potential teachers to implement this strategy effectively in classrooms for teaching and learning materials.

- This study might assist in the design and implementation of a mathematics curriculum that incorporates cultural and traditional aspects, as supported by the NCF-2005 suggestion.

- The mathematics textbooks might have an extensive awareness of the structures, laws, logic, and concepts embedded in Mizo culture. Cultural examples, explanations, and elaborations may be emphasized to enhance the understanding of mathematical concepts, as well as in chapter writing. Additionally, mathematical problems can be framed using traditional materials from Mizo culture and can be included in the practice questions of the chapters/textbooks.

5.5 Limitations of the Study

The findings and conclusions of the present study were constrained by the following limitations, which should be considered before generalising the results:

- During the interview with the Mizo people, many questions were asked; however, the researcher was unable to analyse and report all of them in the study.

- Data on demographic characteristics such as sex, age, locality, and socioeconomic status were obtained but were not included in the study.

- This study is subject to the normal limitations of quasi-experimental design (including non-random assignment); it is possible that the subjects in the two groups differed fundamentally in ways unknown to the experimenter. To address these discrepancies in the experiment, the analysis of covariance technique (ANCOVA) was employed to derive significant conclusions.

- The findings should be applied cautiously to other settings, as the demographics of the students in this study may vary from those in other institutions. Further studies can examine if identical outcomes emerge in alternative contexts.

5.6 Suggestions for Further Research

Based on the experiences and findings of the current study, the researcher proposes the following suggestions for further research.

- The current study was confined only to the Mizo culture; similarly, it can be organized on other cultural, traditional, or tribal communities in India or abroad.

- The current study focused on the variable of ethnomathematics; likewise, it can be organised for ethno-physics, ethno-chemistry, and ethno-science for the same or diverse contexts.

- To investigate the impact of the ethnomathematics teaching strategies, similar research might be conducted with students from different educational boards, different classes, and demographic characteristics.

- The effectiveness of the strategies can be examined through another variable, such as mathematical interest, attitude, mathematical creativity, or problem-solving ability, etc.

- The current study had a small sample size; thus, it might be expanded to include a larger sample with random group assignments.

- Furthermore, similar studies must be conducted to ascertain the generalisability of the findings from the current study.

INTERVIEW SCHEDULE

Dr. Prateek Chaurasia
Supervisor
Department of Education
Mizoram University

(Only for the use of Research work)

TBC Lalramnghaka
Research Scholar
Mizoram University

INSTRUCTION

This **Interview Schedule** has a few questions from different aspects concerning the indigenous peoples of the Mizo Tribe engaged in their traditional activities. Space has been allocated to record the information provided by the Mizo community for each question. No time constraint exists for an answer. Kindly respond without hesitation or tension, precisely as you would in the context of your customary practices. The information you give will be used only for research purposes and will remain confidential.

A. BIOGRAPHIC INFORMATION:

1. Give your personal information.

Name (Hming):	
Gender (Mipa / Hmeichhia):	
Age (Kum)	
Location (Chenna Hmun) Local Language (Tawng hman)	
Kind of Education (Zirna dawn) Level/Grade (San lan) Literate (Lehkhathiam) /Illiterate (Lehlhathiam lo) Trained (Zir)/Untrained (Zir lo)	

2. Which type of education/ training have you achieved? Please Explain.
   Eng ang zirna nge I dawn? Khawngaihin sawifiah rawh?
   ……
   ……
   ……
   ……
   ……
   ……
   ……..
3. What was the age/time when you started these activities and traditional works like collecting clay, making, coloring, designing, etc.? What was your first activity, and how did you do it?
   Kum engzat atangin nge Mizo thil (em, kho, puantah, etc.) siam I tan? Eng nge I siam/tah hmasak ber? Engtin nge I tih?
   ……
   ……
   ……
   ……
   ……
   ……
   ……
   ……
4. Did you undergo any institutional or professional training to perform these activities? If yes, please explain.
   Heng tuna I thiam ang hi a zirna Sikul/a thiam te hnen Atanga I zir a ni em? A nih chuan, han sawi zau teh?
   ……
   ……
   ……
   ……
   ……
   ……
   ……
   ……

B. Mizo Cultural Materials:

1. What are the different Mizo baskets? How do they use it?

   Mizo in Mau hmang a bawm siam eng te nge kan neih? Eng atan nge an hman?

Sl.	Name
1	
2	
3	
4	
5	
6	
7	

2. Give the list of Mizo traps (rats, birds, etc.) and their making mechanism?

   Mizo thang chi hrang hrang leh a siam dan sawi rawh?

Sl.	Name
1	
2	
3	
4	
5	
6	
7	

3. How does Mizo culture utilize clay for making materials?

   Hlum atangin Mizo ten eng hmanrua nge an siam?

4. In what way is Mithun Horn related to Mizo culture?
   Engtiang in nge Mizo hman leh Fungki a inlaichin?
   ……
   ……
   ……
   ……
   ……
   ……
   ……
   ……
   ……
5. Explain how a typical Mizo house is constructed.
   Mizopa insak dan chipchiar takin sawi rawh?
   ……
   ……
   ……
   ……
   ……
   ……
   ……
   ……
   ……

6. According to your knowledge, can you explain the various Mizo cultural musical instruments that exist?
   Zo Rimawi tumna hmanruai chi hrang hrang i hirat han sawi teh?
   ……
   ……
   ……
   ……
   ……
   ……
   ……
   ……

7. Name the Mizo wooden material and its usage?
   Thing hmanga siam hmanrua leh a hman dan sawi rawh?
   ……
   ……
   ……
   ……
   ……
   ……
   ……
   ……

Sl.	Name
1	
2	
3	
4	
5	
6	
7	

8. List of Mizo household items made from bamboo, clay, wood, etc.
   Mau,hlum,thing,etc te hmang hian Mizo inchhung bungrua eng te nge kan siam?
   ……
   ……
   ……
   ……
   ……
   ……
   ……
   ……

Sl.	Name
1	
2	
3	
4	
5	
6	
7	

9. What are the different Mizo jars/containers provided/given by nature?
   Siamtu'n Thlairah atangin eng Um (Saum bur, Tuithawl, etc.) te nge min pek?
   ……
   ……
   ……
   ……
   ……
   ……
   ……
   ……

Sl.	Name
1	
2	
3	
4	
5	
6	
7	

10. What materials are used for making Mizo traditional hand-woven fabrics?

Mizo lasai na hmanrua sawi rawh?

Sl.	Name
1	
2	
3	
4	
5	
6	
7	

……

……

……

……

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……

11. Name the different tools used for jhum cultivation and other materials?

Ram hnathawh nan eng hmanrua te nge kan hman?

Sl.	Name
1	
2	
3	
4	
5	
6	
7	

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……

12. Give any other Mizo cultural materials as per your knowledge.

Mizo hmanrua dang I hriat te sawi rawh?

……

……

……

……

……

……

Lesson Plan 1

Date : _____ Class : VIII

Section : _____ Period : _____

Duration: _____ Subject: _____

Unit : Understanding Quadrilaterals Topic : Types of polygons and their properties

General Objectives:

To develop: -

1. Interest in learning mathematics.
2. The abilities of imagination, reasoning, and observation.
3. The scientific approach in mathematics for the students.
4. Spatial ability and apply it in real life.
5. The understanding of the fundamentals of different geometric shapes and figures.

Learning Objectives (Specific):

After teaching the lesson, the learner will be able to:

1. **Identify** different types of polygons.
2. **Define** the meaning of diagonals.
3. **Understand** convex and concave polygons
4. **Recognize** regular and irregular polygons.
5. **Solve** the problems based on the angle sum property.

Process Skills/ Teaching Method:

- Explanation (with example), Demonstration, Heuristic, and Induction method.

Learning Resources: (TLM/ Teaching Aids)

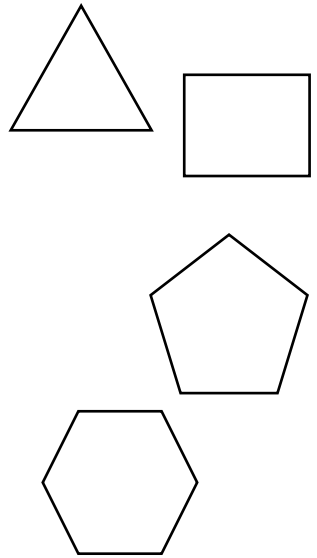
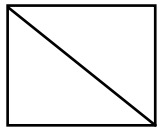
1. Model: Raw Chaicheh (Bamboo tongue), Favah (Sickle), Belval, Thlangra (Winnowing tray), Pher (Mizo bamboo mat board), Hmui (A spinning wheel), Tuium (Traditional water bottle)
2. Chart
3. Black/Whiteboard
4. Marker/chalk

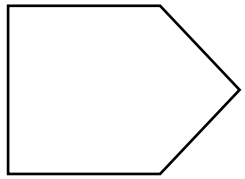
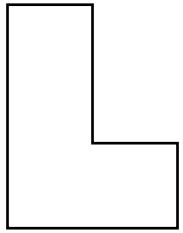
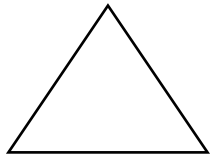
Learner's Previous Knowledge

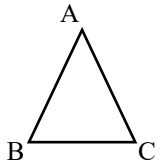
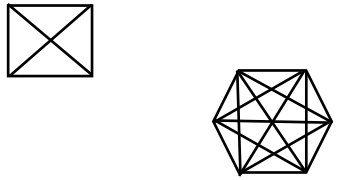
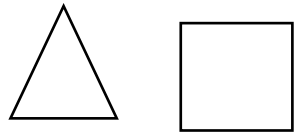
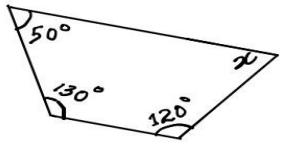
The learners are familiar with the basic concepts of curves, polygons, lines, angles, and the properties of a triangle.

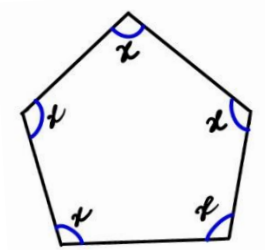
Introduction:

S. No.	Teacher's Activity	Student's Activity
1.	Do you know a line segment? The teacher shows a model bamboo tongue (Raw Chaicheh).	A line that has two endpoints.
2.	Do you know how many types of plane curves there are?	Two
3.	Please, name them.	Open (Favah) and Closed curves (Belval)
4.	What is a polygon?	A simple closed curve made up of line segments is known as a polygon.
5.	Give some examples of a polygon. The teacher shows a few models, such as Thlangra (Triangle), Pher (Quadrilateral), and Hmui (Hexagon).	Triangle, quadrilateral, pentagon, hexagon, etc.

Statement of the Problem:					
Today, we will learn about and discuss the types of polygons and their properties.					
Presentation:					
S. No.	**Teaching Point**	**5E component**	**Teachers' Activity**	**Students' activity**	**Black/white board work**
1.	Polygons and each type.	Engage	What is a polygon? The teacher explained and defined that A simple closed curve comprising only line segments is called a polygon. Can you name the types of polygons? Types of polygons: The teacher mentions and shows the different Mizo materials having polygonal shapes, such as Triangle is Thlangra (Winnowing tray) Square is Pher (Bamboo mat board) and Hexagon is Hmui (A spinning wheel)	No response The students will give some responses like Triangle, Quadrilateral, Pentagon, Hexagon, etc.	
2.	Diagonals	Explore	The Teacher will raise a Question: Do you know what a diagonal is? After listening to the students, the teacher defines A diagonal is a line segment connecting two non-consecutive vertices of a polygon.	Students will respond according to their knowledge and understanding.	

			A model example is Tuium (Mizo water bottle) Can you give examples?	Students will give responses.	
3	Convex and Concave polygons	Explain	The teacher asks the students whether they have heard the words 'Convex and concave' before. The teacher defined and explained the convex polygon in this way. Convex polygons are polygons having diagonals inside. A model example of a convex polygon is Lunglehkha (Slate) Can you give an example? Concave polygon: One or more diagonals are outside. Can you give an example?	Students will listen carefully. Square, rectangle, etc. Students may give a response like a star, L-shape figure, etc.	 
4.	Regular and Irregular Polygons	Evaluate	The teacher asks the students, from your understanding, can you tell the meaning of regular and irregular polygons? The teacher explained and defined it as follows.	Some responses may come with equal length and angle. Students listen carefully to understand.	 Equilateral triangle

			Regular polygon: A regular polygon has equal lengths on all sides and identical angles at each vertex. Irregular polygon: An irregular polygon has sides that are not equal and angles that differ.		 Rectangle
5.	Angle sum property	Evaluate	Do you remember the angle sum property of a triangle? What is the sum of the measurements of the three angles of a triangle?	yes 180^0	 $\angle A+\angle B+\angle C=180^0$
6.	Numerical	Explore	How many diagonals does each of the following have? a) A convex quadrilateral b) A regular hexagon	a) 2 b) 9	
7.	Numerical	Explore and Evaluate	State the names of a regular polygon of a) 3 sides b) 4 sides	Triangle & Square	
8.	Numerical		1. Find the angle measures of '*x*' Solution: Here, we have to use the angle sum property, Do you remember the formula?	Students' response 360^0	

		Explain Explain and Evaluate	Please look at the board and solve it with me. $50+130+120+x= 360$ $\Rightarrow 300+ x=360$ $\Rightarrow x =360-300$ $\Rightarrow x =60$ 2. Find the angle measures of 'x' Solution: Since it is a pentagon, all sides are equal, with 5 equal angles. We have, $\Rightarrow \quad x+x+x+x+x =540$ $\Rightarrow \quad 5x = 540$ $\Rightarrow \quad x = \frac{540}{5} = 108^0$	Students will listen, observe, and start calculating. Students will observe, listen, and solve the problem carefully.	

Closer Statement:

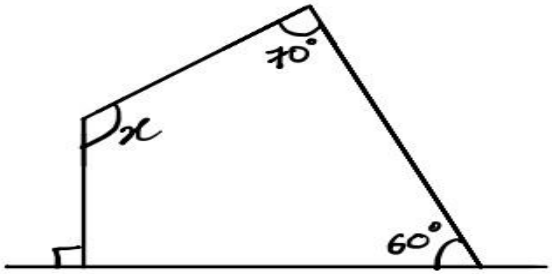
So, today we have learned about the types of polygons and their properties.

Recapitulation:

1. Polygons and each type.
2. Diagonals.
3. Convex and Concave polygon.
4. Regular and Irregular polygons.
5. Angle sum property.

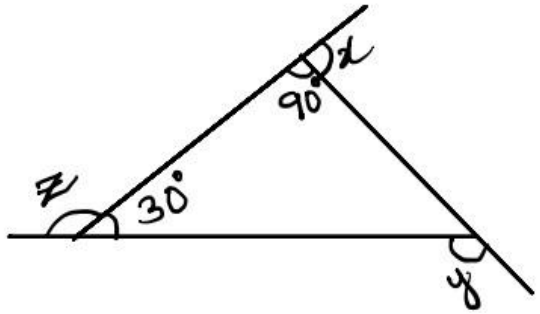
Assessment:

1. How many diagonals does a triangle have?
2. State the names of a regular polygon of 6 sides.
3. Find the angle measure of '*x*' from the diagram.



Home Assignment:

1. What is the sum of the measures of the angles of a convex quadrilateral? Will this property hold if the quadrilateral is not convex?
2. Name any Mizo materials having a polygonal shape.
3. Find the angle measure of '*x*' from the diagram.



Miniatures of materials used in the lesson plan for teaching:

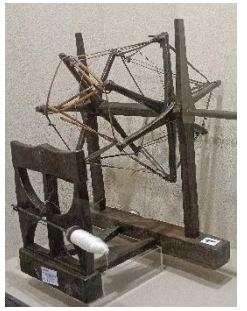
Raw Chaicheh (Bamboo tongue)

Favah (Sickle)

Belval

Thlangra (Winnowing tray)

Pher (Mizo bamboo mat board)



Hmui (A spinning wheel)

Tuium (Traditional water bottle)

Lesson Plan 2

Date : _____ Class : VIII

Section : _____ Period : _____

Duration: _____ Subject: _____

Unit : Understanding Quadrilaterals Topic : **Measure of exterior angles and kinds of quadrilaterals.**

General Objectives:

To develop:-

1. Interest in learning mathematics.
2. The abilities of imagination, reasoning, and observation.
3. The scientific approach in mathematics in the students.
4. The understanding of reality and applying it in real life.
5. Accredit and get knowledge content in the lesson.

Learning Objectives (Specific):

After teaching the lesson the learner will be able to:

1. **Know** the types of quadrilaterals.
2. **Understand** exterior angles and kinds of quadrilaterals.
3. **Calculate** the exterior angles of polygons.
4. **Analyse** the relationship between different kinds of quadrilaterals
5. **Describe** how to solve the problem based on the exterior angle and kinds of quadrilaterals.

Process Skills/ Teaching Method:

- Explanation (with example), Demonstration, Heuristic, and Induction method.

Learning Resources: (TLM/ Teaching Aids)

1. Model: Emping (Closed wave carrying basket), Paikawng (Open wave carrying basket), Thul (storage basket), Kho/Fawng (Square base small basket), Arbawm (Chicken basket)
2. Chart
3. Black/Whiteboard
4. Marker/chalk

Learner's Previous Knowledge

The Learners are familiar with the basic concepts of curves, polygons, lines, angles, and angle sum properties of a triangle. Also, the students know convex, concave, regular, and irregular polygons. The learner also knows the sum of the interior angles of a polygon.

Introduction:

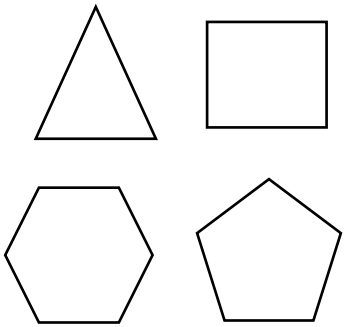
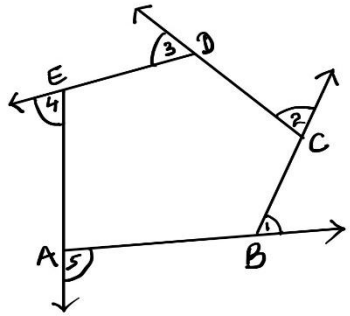
S. No.	Teacher's Activity	Student's Activity
1.	The teacher asks for the sum of the measures of the external angles of any polygon.	360^0
2.	What is a quadrilateral? The teacher shows a few models of a quadrilateral. They are Emping, Paikawng, Arbawm, Thul, and Kho/Fawng.	A quadrilateral is a closed shape with four sides, four vertices, and four angles. It has four interior angles of 360 degrees.
3.	Please, name a parallelogram that you know.	Trapezium, Kite, Parallelogram, Square, and Rectangle.
4.	Does the sum of the interior angle of every parallelogram are equal?	Yes.

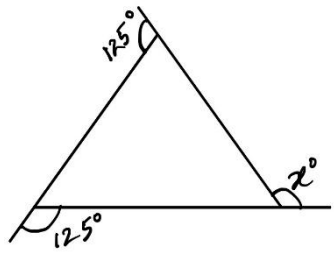
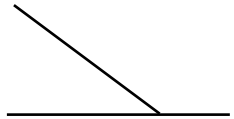
5.	If yes, can you please tell me how much is the total?	360^0

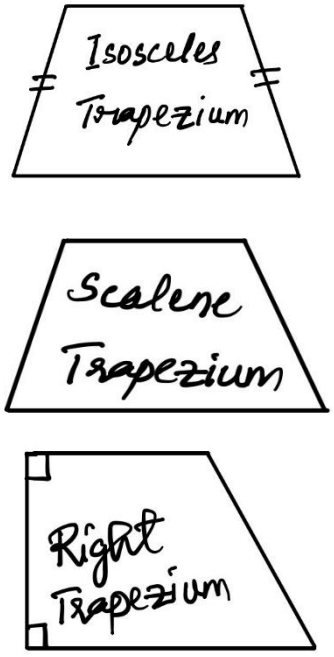
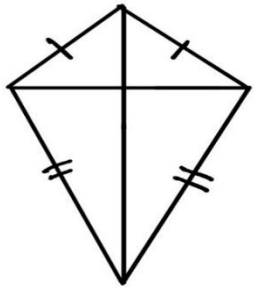
Statement of the Problem:

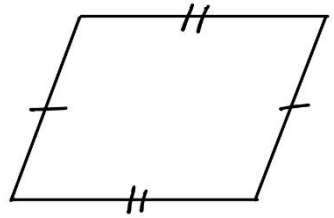
So, today we will study and discuss **Measure of exterior angles and kinds of quadrilaterals.**

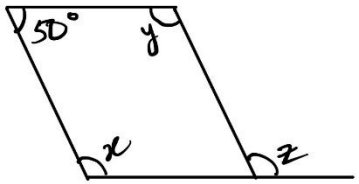
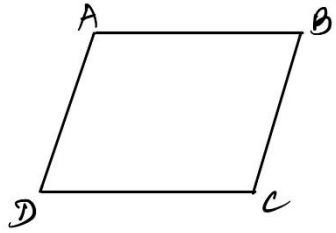
Presentation:

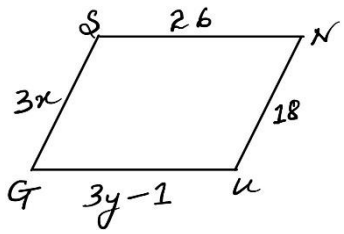
S. No.	Teaching Point	5E component	Teachers' Activity	Students' activity	Black/white board work
1.	The sum of the measures of the exterior angles of a polygon.	Engage and Explain	The Teacher tries to get students' previous knowledge and asks for the sum of the interior angles of a polygon. After students answer, the teacher demonstrates the model mentioned below. Thlangra (Winnowing tray) = 180^0 Pher (Bamboo mat board) = 360^0 Hmui (A spinning wheel) = 720^0 Now, after explaining the interior angles of a polygon, the teacher also explains the exterior angles of a polygon using a different polygon. The teacher concludes that the sum of the measures of the exterior angles of a polygon is 360^0.	Students will respond like, Triangle=180^0 Square/Rectangle= 360^0 Hexagon=720^0 Students will listen very carefully.	 

2.	Numerical	Elaborate and Evaluate	Qns. Find the value of 'x' Ans: The teacher asks the students, what is the sum of the measures of a polygon. We have, $\Rightarrow 125^0+125^0+x = 360$ $\Rightarrow x = 360 - 250$ $\Rightarrow x = 110^0$.	Students will give the answer 360^0 Students will listen, observe, and start calculating.	
3	Numerical	Elaborate, Explain Evaluate	Qns. How many sides does a regular polygon have if each of its interior angles is 165°? Ans: The teacher asks about the angle of a straight line and from that knowledge, Exterior angle = 180^0 - interior angle $= 180^0 - 165^0 = 15^0$ We have the number of sides = 360/15 = 24. The regular polygon has 24 sides.	Students will response 180^0	 Straight line = 180
4.	Trapezium	Explain	Kind of Quadrilateral. The teacher said that Based on the nature of the sides or angles of a quadrilateral, it gets special names. One of the first kinds is trapezium.	Students will start realizing that there can be different quadrilaterals.	

			The teacher asks, do you know a trapezium? The teacher explains that a trapezium is a quadrilateral a pair of parallel sides. There are three types a) Isosceles trapezium The trapezium which has a length of equal length b) Scalene Trapezium The trapezium which neither has length nor equal sides. c) Right trapezium The trapezium which has a pair of right angles.	No response and students will listen very carefully.	
5.	Kite	Explain	The traches ask, do you know an ordinary kite? The teacher shows a model (Ordinary kite) and starts demonstrating that a Quadrilateral kite is similar to an ordinary kite having exactly two distinct consecutive pairs of equal length and one pair of opposite angles is equal.	Students will answer by saying 'Yes'. Students will look at the model and will listen to the teacher.	

6.	Parallelogram	Explain	The teacher questions the learner, do you hear the words parallelogram? Do you think that it has something to do with parallel lines? Can you share your ideas? After the students shared their thoughts and ideas, the teacher concluded that A parallelogram is a Quadrilateral whose opposite sides are parallel. The teacher also discusses a few properties of a parallelogram under a) Opposite sides of a parallelogram are of equal length. b) The opposite angles of a parallelogram are of equal measure. c) The diagonal of a parallelogram bisects each other	Students will be familiar with parallelograms. Students will think that there will be parallel sides. Students will share their ideas like both the opposite sides will be parallel.	

7.	Numerical	Explore and Evaluate	Qns. Find the values of the unknown *x, y, z.* Ans: The teacher asks, can anyone share the meaning and occurrence of Co-interior angles. Now we know that, $\angle y+50=180$ (Co-interior $\angle$) $\Rightarrow \angle y= 180-50$ $\Rightarrow \angle y = 130$ And, $\angle x=\angle y$ (opposite angles) $\therefore \angle y=130$. Again, $\angle z=\angle y$ (Alternate angle) $\therefore \angle z=130$	Students will respond that Co-interior angles occur between two parallel lines when they are intersected by a transversal.	
8.	Numerical		Qns. The measures of two adjacent angles of a parallelogram are in the ratio 3:2. Find the measures of each parallelogram angle. Ans: Do you know an adjacent, the teachers ask. The teacher starts solving the problems Let ABCD be a parallelogram in which $\angle A:\angle B = 3:2$ We have, $\angle A = 3x$ and $\angle B = 2x$ But, $\angle A+\angle B=180^0$ (Co-interior angles) $\Rightarrow 3x+2x=180$	No response Students look at the board and listen carefully.	

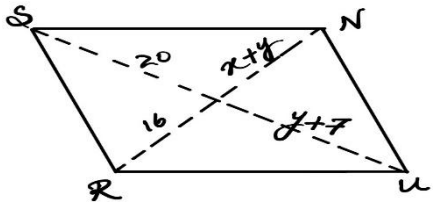
			$\Rightarrow 5x=180$ $\Rightarrow x=180/5= 36$ Now, $\angle A=3x=3 \times (36) = 108$ $\angle B=2x=2 \times (36) = 72$ We have, $\angle A=\angle C=108$ and $\angle B=\angle D=72$		
9.	Numerical	Engage and Explain	Qns. The following figure GUNS is a parallelogram. Find *x and y*. (Length is in cm) Ans: Do we remember the properties of a parallelogram? By using that property, We have GU = SN $\Rightarrow$ 3y-1 = 26 $\Rightarrow$ 3y = 26+1 $\Rightarrow$ 3y = 27 $\Rightarrow$ y = 27/3 $\Rightarrow$ y = 9.	Students will respond that opposite sides of a parallelogram are equal.	
Closer Statement: So, today we have learned about the measure of exterior angles and kinds of quadrilaterals.					

Recapitulation:

1. The sum of the measures of the exterior angles of a polygon.
2. Kinds of quadrilaterals
   a) Trapezium
   b) Kite
   c) Parallelogram

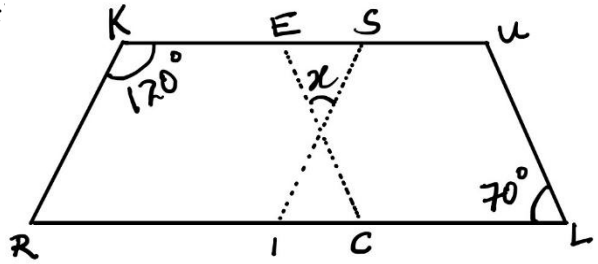
Assessment:

1. How many diagonals does a triangle have?
2. State the names of a regular polygon of 6 sides.
3. The following figure RUNS is a parallelogram. Find *x and y*. (Length is in cm)



Home Assignment:

1. Draw a rough figure of a quadrilateral that is not a parallelogram but has exactly two opposite angles of equal measure.
2. Two adjacent angles of a parallelogram have equal measures. Find the measure of each of the angles of the parallelogram.
3. In the below figure both RISK and CLUE are parallelograms. Find the value of '*x*



Miniatures of materials used in the lesson plan for teaching:

Arbawm (Chicken basket)

Paikawng (Open wave carrying basket)

Thul (storage basket)

Thlangra (Winnowing tray)

Pher (Mizo bamboo mat board)

Kho/Fawng (Square base small basket)

Lesson Plan 3

Date : _____ Class : VIII

Section : _____ Period : _____

Duration: _____ Subject: _____

Unit : Understanding Quadrilaterals Topic : Some special parallelogram

General Objectives:

To develop:

1. Interest of students in learning mathematics.
2. Abilities of imagination, reasoning, and observation.
3. Scientific approach in mathematics in the students.
4. Reality and apply it in real life.
5. Accredited and knowledge content in the lesson.

Learning Objectives (Specific):

After teaching the lesson the learner will be able to:

1. **Identify** and recognize Quadrilateral.
2. **Classify** about types of Quadrilaterals.
3. **Calculate** the problem based on the types of different Quadrilaterals.
4. **Correlate** different types of Quadrilaterals.
5. **Compare** and **conclude** the similarities and dissimilarities of quadrilaterals.

Process Skills/ Teaching Method:

- Explanation (with example), Demonstration, Heuristic, and Induction method.

Learning Resources: (TLM/ Teaching Aids)

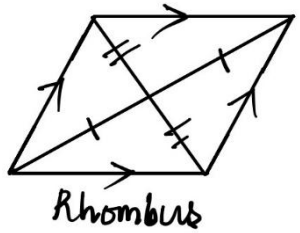
1. Model: Emping (Closed wave carrying basket), Paikawng (Open wave carrying basket), Thul (Storage basket), Kho/Fawng (Square base small basket), Arbawm (Chicken basket), Suvel (Cotton winding machine), Chhihri (Sieve), Lunglehkha (slate).
2. Chart
3. Black/Whiteboard
4. Marker/chalk

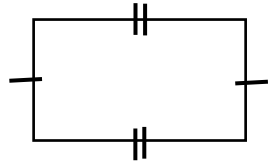
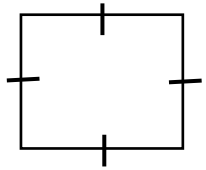
Learner's Previous Knowledge

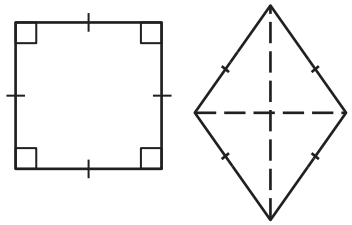
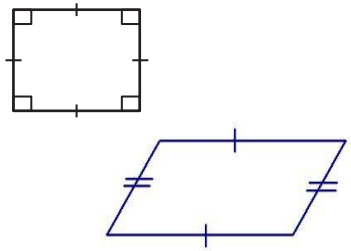
The students are familiar with the basic concepts of the sum of the measures of the exterior angle of a polygon. Also, the students are familiar with the properties of trapezium, kite, and parallelogram.

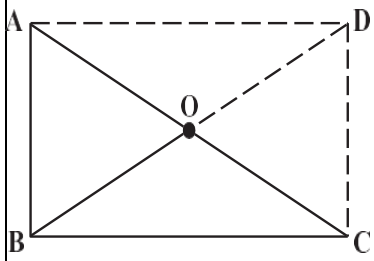
Introduction:

S. No.	Teacher's Activity	Student's Activity
1.	What is a parallelogram?	A parallelogram is a two-dimensional geometrical shape whose sides are parallel to each other
2.	Name some parallelogram that you know.	Rhombus, rectangle, square
3.	What is the sum of the interior and exterior angles of a parallelogram?	Both are 360^0 each.
4.	Do you think it is applicable in real-life situations	Yes, it can be seen and useful in day-to-day life.
5.	Do you think our ancestors could make use of their time?	Yes, they make some materials in the shapes of squares, rectangles, rhombuses, etc.

Statement of the Problem:					
So, today we are going to study and discuss Some special parallelograms.					
Presentation:					
S. No.	**Teaching Point**	**5E component**	**Teachers' Activity**	**Students' activity**	**Black/white board work**
1.	Rhombus	Engage and Explain	The teacher asks, do you know rhombus? Can you relate with any other parallelogram? Here is the definition of a rhombus the opposing angles and sides are equal. A rhombus also has equal-length sides, and its diagonals split into right angles. Can you give examples of a rhombus? Also, the teacher explains how a square can easily be turned into a rhombus by showing a few models of squares such as: Emping (Closed wave carrying basket), Paikawng (Open wave carrying basket), Thul (Storage basket), Kho/Fawng (Square base small basket).	Students will respond like it can be related to a square but with unequal diagonal length. Diamond Students will look at the models.	

			The teacher also discusses the properties of Rhombus saying that the diagonal of a rhombus is perpendicular bisectors of one another.	Students will listen carefully	
2.	Rectangle	Engage and Explain	Are you familiar with rectangles, the teacher asks? The teacher shows a few models and pictures of a rectangle and lets them touch and feel the mathematical ideology in them. Following are the models and pictures brought by the teacher. Pher (Mizo bamboo mat board) Lunglehkha (Slate) Suvel (Cotton winding machine) Mizo In (Typical Mizo house) The teacher concludes a rectangle is a parallelogram with equal angles and has an opposite side of equal length and diagonals.	Yes Students will share the picture and model brought by the teacher.	
3	Square	Engage and Explain	The teacher asks, what do you understand by square? The teacher explains: A square is a rectangle with equal sides which means a square has all the properties of a	All sides equal Students will listen carefully	

			rectangle with an additional requirement that all the sides have equal length. Also, the square like the rectangle has diagonals of equal length. The models of a Square are the base of Emping (Closed wave carrying basket), Paikawng (Open wave carrying basket), Thul (Storage basket), and Kho/Fawng (Square base small basket).		
4.	Numerical	Elaborate and Explain	Qns. Identify all the quadrilaterals that have four sides of equal length. Ans: The teacher asks the students from the previous lecture. The teacher gives some hints and concludes that squares or rhombuses have equal lengths.	Students will discuss and give a response like square and rhombus.	
5.	Numerical		Qns. Explain how a square is a parallelogram. Ans: The teacher asks students whether they still remember a parallelogram or not. A square has its opposite side parallel, so it is a parallelogram.	Students will remember the properties of squares and parallelograms and will give responses.	

6.	Numerical	Elaborate and Explain	Qns. ABC is a right-angled triangle and O is the midpoint of the side opposite to the right angle. Explain why O is equidistant from A, B, and C. (The dotted lines are drawn additionally to help you) Ans: Since, AB ‖ DC and AD ‖ BC i.e. Opposite sides are parallel. Hence, ABCD is a parallelogram in which AC and BD are its diagonals. We know that in a parallelogram, diagonals bisect each other. ∴ AO=OC=OB Hence, A, B, and C are equidistant from O.		

Closer Statement:

So, today we have learned about some special parallelograms.

Assessment:

1. Identify all the quadrilaterals that have four right angles.
2. Explain how a square is a rhombus.
3. Explain why a rectangle is a convex quadrilateral.

Recapitulation:
1. Meaning and properties of a) Rhombus b) Rectangle c) Square
Home Assignment:
1. Explain how a square is a rectangle. 2. Explain why a square is a convex quadrilateral.

Miniatures of materials used in the lesson plan for teaching:

Arbawm (Chicken basket)

Paikawng (Open wave carrying basket)

Thul (storage basket)

Thlangra (Winnowing tray)

Pher (Mizo bamboo mat board)

Kho/Fawng (Square base small basket)

Lunglehkha (Slate)

Suvel (Cotton Winding Machine)

Lesson Plan 4

Date : _____ Class : VIII

Section : _____ Period : _____

Duration: _____ Subject: _____

Unit : Practical Geometry Topic : Construction of quadrilaterals with given sides and diagonal.

General Objectives:

To develop: -

1. Interest in learning geometry.
2. The abilities of imagination, reasoning, and observation.
3. The scientific approach in mathematics in the students.
4. Spatial ability and apply it in real-life situations.
5. The idea of drawing different types of quadrilaterals.

Learning Objectives (Specific):

After teaching the lesson, the learner will be able to: -

1. **Name** different quadrilaterals.
2. **Describe** how different quadrilaterals are drawn.
3. **Construct** quadrilaterals by themselves.
4. **Distinguish** different quadrilaterals by names.
5. **Develop** techniques and skills in drawing quadrilaterals.

Process Skills/ Teaching Method:

- Explanation (with example), Demonstration, Heuristic, and Induction method.

Learning Resources: (TLM/ Teaching Aids)

1. Model: - Chaicheh (tongue), Suankual, Raw chaicheh (bamboo tongue), Kho/Fawng (Square base small basket), Arbawm (Chicken basket), and Lunglehkha (slate).
2. Chart
3. Black/Whiteboard
4. Marker/chalk

Learner's Previous Knowledge

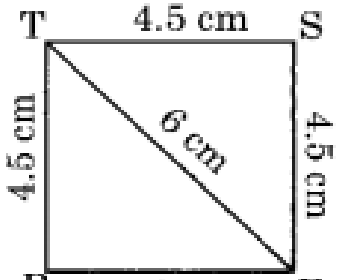
The students are familiar with the basic concepts of quadrilateral, parallelogram, and rhombus.

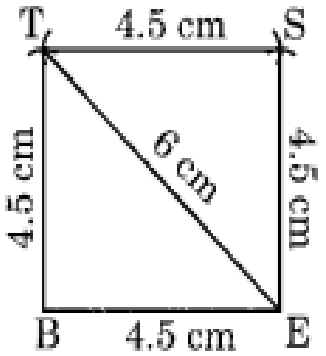
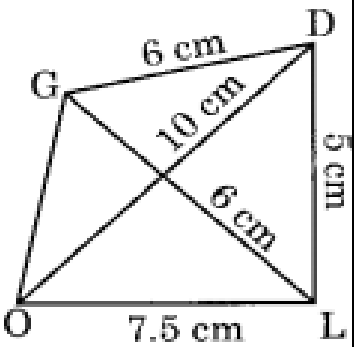
Introduction:

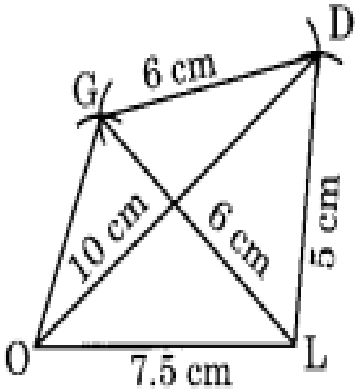
S. No.	Teacher's Activity	Student's Activity
1.	Are we all familiar with drawing 30^0, 45^0,60^0, 90^0 without using a protector?	Yes, we had studied in the previous class.
2.	Have you learned how to draw a triangle in the previous class?	Yes
3.	How many sides and angles are required for drawing a triangle?	Three sides and three angles.
4.	How many given measurements are required to draw a unique quadrilateral?	Five measurements are required.
5.	Can you name any Mizo flexible materials?	Chaicheh (tongue), Suankual, Raw chaicheh (A Bamboo Tong).

Statement of the Problem:					
So, today we will be studying and discussing the construction of quadrilaterals with given sides and diagonals.					
Presentation:					
S. No.	**Teaching Point**	**5E component**	**Teachers' Activity**	**Students' activity**	**Black/white board work**
1.	Sides and angles of a quadrilateral	Engage	What is a quadrilateral? Exactly, a quadrilateral is a four-sided shape having four sides and angles, but depending upon the length and of sides and angles, there can be different names. How many sides and angles does a quadrilateral have? Can you name any Mizo material having a quadrilateral shape? Other Mizo materials can include Kho/Fawng (Square base small basket), Arbawm (Chicken basket), and Lunglehkha (slate).	A quadrilateral is a closed shape having four sides and angles. It has four sides and four angles. Emping (Closed wave carrying basket), Paikawng (Open wave carrying basket), and Thul (Storage basket).	
			The teacher asks, can there be a chance of forming a different quadrilateral by slightly moving the sides?	Students will give no response.	

2.	Required side and angles for constructing quadrilateral	Explain	The teacher explains with the given example, saying that giving side of the rectangle having Length = 9 cm, breadth = 6 If the sides are slightly moving, the angles will change and that will bring a new quadrilateral called a parallelogram. What are the minimum criteria for drawing a unique quadrilateral? Exactly, we need to give four sides and a diagonal. Are there any other possibilities? For the numerical, we will try to draw a quadrilateral a) when four sides and one diagonal are given and b) When two diagonals and three sides are given. The teacher mentions that the cultural materials, such as Chaicheh (tongue), Suankual, Raw	When Four sides and one diagonal are given Yes, when two diagonal and three sides are given.	

			Chaicheh (bamboo tongue), can be used as a compass, which can draw a certain degree.		
3	Numerical	Explain and elaborate	Qns. Construct a Rhombus BEST BE = 4.5 cm ET = 6 cm Ans: The teacher asks, what materials do we need for drawing rhombus BEST. Can you please name Mizo materials that are as flexible as a compass? Steps of construction. 1. Draw a line segment BE=4.5cm 2. With B as the centre and a radius of 6cm, draw an arc. 3. With E as centre and a radius of 4.5cm, draw another arc to intersect the previous arc at S. 4. Join BE and ES 5. With E as centre and a radius of 6cm, draw another arc.	Compass and scale. Chaicheh (tongue), Suankual, Raw chaicheh (A Bamboo Tong). Students will listen and observe.	 (Rough sketch)

			6. With B as centre and a radius of 4.5cm, draw another arc to intersect the previous arc at T. 7. Join BT, ET, and TS. ∴ BEST is the required Rhombus.		 (Fair figure)
4.	Numerical	Explain and elaborate	Qns. Construct a Quadrilateral GOLD OL = 7.5cm, GL = 6cm, GD= 6cm LD=5cm, OD=10cm Ans: The teacher asks the students to draw a construction along with him. Steps of construction. 1. Draw a line segment OL = 7.5cm. 2. With L as centre and a radius of 5cm, draw an arc.		 (Rough sketch)

			3. With O as centre and a radius of 10cm, draw another arc to intersect the previous arc at D. 4. Join LD and OD 5. With L as centre and a radius of 6cm, draw another arc 6. With D as centre and a radius of 6 cm, draw another arc to intersect the previous arc at G. 7. Join DG, GL and OG. ∴GOLD is the required quadrilateral.	Students will observe, listen and draw a quadrilateral.	 (Fair figure)

Closer Statement:

So, today we have learned about the Construction of quadrilaterals with given sides and diagonals.

Recapitulation:

1. Sides and angles of a quadrilateral
2. Required side and angles for constructing quadrilateral

Assessment:

1. Construct the following quadrilaterals

a) Quadrilateral LIFT

LI = 4cm

IF = 3cm

TL = 2.5cm

LF = 4.5 cm

IT = 4cm

b) Quadrilateral MORE

OR = 6cm

RE = 4.5cm

EO = 7.5cm

Home Assignment:

1. Construct the following quadrilaterals

a) Rhombus BEND

BN = 5.6cm

DE = 6.5cm

b) Quadrilateral JUMP

JU = 3.5cm

UM = 4cm

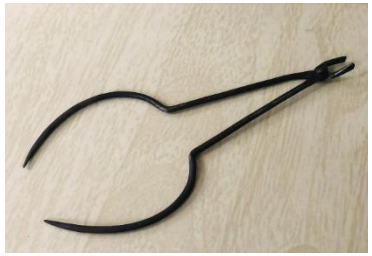
MP = 5cm

PJ = 4.5cm

PU = 6.5

Miniatures of materials used in the lesson plan for teaching:

Arbawm (Chicken basket)



Suankual

Raw Chaicheh (A Bamboo Tongue)

Chaicheh (Tongue/Nippers/Pincers)

Lunglehkha (Slate)

Kho/Fawng (Square base small basket)

Suvel (Cotton Winding Machine)

Lesson Plan 5

Date : _____ Class : VIII

Section : _____ Period : _____

Duration: _____ Subject: _____

Unit : Practical geometry Topic : Construction of quadrilateral with given adjacent sides and angle.

General Objectives:

To develop: -

1. Interest in learning geometry.
2. The abilities of imagination, reasoning, and observation.
3. The scientific approach in mathematics in the students.
4. Spatial ability and apply it in real-life situations.
5. The idea of drawing different types of quadrilaterals.

Learning Objectives (Specific):

After teaching the lesson, the learner will be able to: -

1. **Name** different quadrilaterals.
2. **Describe** how different quadrilaterals are drawn.
3. **Construct** quadrilaterals by themselves.
4. **Distinguish** different quadrilaterals by name.
5. **Develop** techniques and skills in drawing quadrilaterals.

Process Skills/ Teaching Method:

- Explanation (with example), Demonstration, Heuristic, and Induction method.

Learning Resources: (TLM/ Teaching Aids)

1. Model: - Chaicheh (tongue), Suankual, Raw chaicheh (bamboo tongue), Kho/Fawng (Square base small basket), Arbawm (Chicken basket), and Lunglehkha (slate).
2. Chart
3. Black/Whiteboard
4. Marker/chalk

Learner's Previous Knowledge

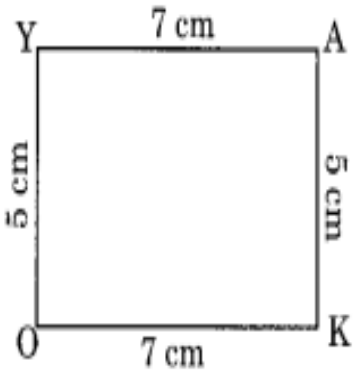
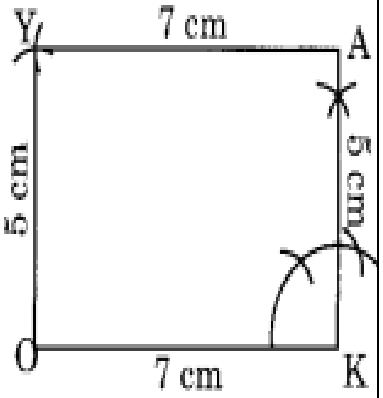
The students are familiar with the basic concepts of rectangle, square, triangle, parallelogram, and circle

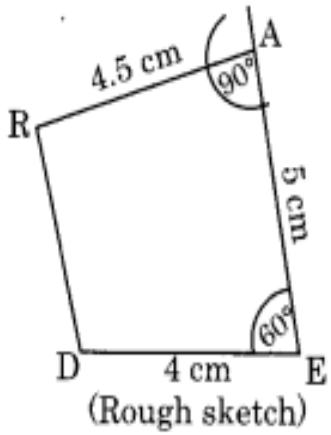
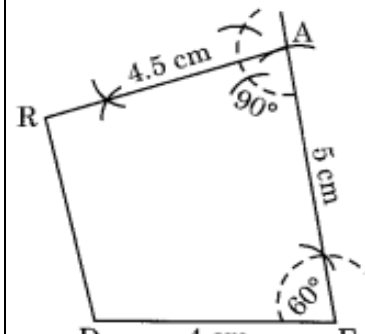
Introduction:

S. No.	Teacher's Activity	Student's Activity
1.	Are we all familiar with drawing 30^0, 45^0,60^0, 90^0 without using a protector?	Yes, we had studied in the previous class.
2.	Have you learned how to draw a triangle in the previous class?	Yes
3.	How many sides and angles are required for drawing a triangle?	Three sides and three angles.
4.	How many given measurements are required to draw a unique quadrilateral?	Five measurements are required.
5.	Can you name any Mizo flexible materials?	Chaicheh (tongue), Suankual, Raw chaicheh (A Bamboo Tong).

Statement of the Problem:					
So, today we are going to study and discuss the construction of a quadrilateral with given adjacent sides and angles.					
Presentation:					
S. No.	**Teaching Point**	**5E component**	**Teachers' Activity**	**Students' activity**	**Black/white board work**
1.	Sides and angles of a quadrilateral	Engage	What is a quadrilateral? Exactly, a quadrilateral is a four-sided shape having four sides and angles, but depending upon the length and of sides and angles, there can be different names. How many sides and angles does a quadrilateral have? Can you name any Mizo material having a quadrilateral shape? Other Mizo materials can include Kho/Fawng (Square base small basket), Arbawm (Chicken basket), and Lunglehkha (slate).	A quadrilateral is a closed shape having four sides and angles. It has four sides and four angles. Emping (Closed wave carrying basket), Paikawng (Open wave carrying basket), and Thul (Storage basket).	
			The teacher asks, can there be a chance of forming a different quadrilateral by slightly moving the sides?	Students will give no response.	

2.	Required side and angles for constructing quadrilateral	Explain	The teacher explains with the given example, saying that the given side of the rectangle having Length = 9 cm, breadth = 6 If the sides are slightly moving, the angles will change and that will bring a new quadrilateral called a parallelogram. What are the minimum criteria for drawing a unique quadrilateral? Exactly, we need to give four sides and a diagonal. Are there any other possibilities? For the numerical, we will try to draw a quadrilateral a) when two adjacent sides and three angles are given. b) When three sides and two included angles are given. The teacher mentions that the cultural materials, such as Chaicheh (tongue), Suankual, Raw Chaicheh (bamboo tongue), can be used as a compass, which can draw a certain degree.	When Four sides and one diagonal are given Yes, when two diagonal and three sides are given.	

3	Numerical		Qns: Construct a Rectangle OKAY OK = 7cm KA = 5cm Ans: The teacher asks, what materials do we need for drawing rhombus OKAY. Can you please name Mizo materials that are as flexible as a compass? Step of construction: 1. Draw a line segment OK = 7cm 2. Draw $\angle KOX = 90^0$ 3. Cut off OX at Y such that OY = 5cm. 4. With Y as a centre and radius of 7cm, draw an arc. 5. With K as centre and a radius of 5cm, draw another arc to intersect the previous arc at A. 6. Join AY and AK $\therefore$ OKAY is the required rectangle.	Compass and scale. Chaicheh (tongue), Suankual, Raw chaicheh (A Bamboo Tong).	 (Rough sketch)  (Fair figure)

4.	Numerical		Qns: Construction of a quadrilateral DEAR DE = 4cm EA = 5cm AR = 4.5cm $\angle E = 60^0$ $\angle A = 60^0$ Ans: The teacher asks the students to draw a construction along with him. Steps of construction: 1. Draw a line segment AE = 5cm. 2. Draw $\angle EAP = 90^0$ 3. Cut off AP at R such that AR = 4.5cm 4. Draw $\angle AEY = 60^0$ 5. Cut off EY at D such that ED = 4cm 6. Join RD $\therefore$ DEAR is the required quadrilateral.		 (Rough sketch)  (Fair figure)
Closer Statement:					
So, today we have learned about the construction of a quadrilateral with given adjacent sides and angles.					

Recapitulation:

1. How many diagonals does a triangle have?
2. State the names of a regular polygon of 6 sides.
3. (diagram)

Assessment:

1. Construct the following quadrilaterals
   a) PLAN

      PL = 4cm

      LA = 6.5 cm

      $\angle P = 90^0$

      $\angle A = 110^0$

      $\angle N = 85^0$

   b) TRUE

      TR = 3.5cm

      RU = 3cm

      UE = 4cm

      $\angle R = 75^0$

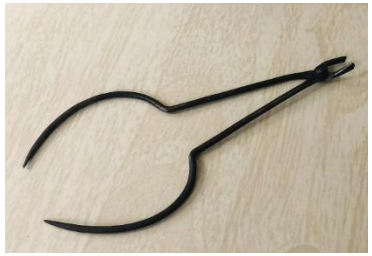
      $\angle U = 90^0$

Home Assignment:

1. Construct a quadrilateral ABCD, where AB = 4cm, BC= 5cm and $\angle B = 105^0$ and $\angle C = 80^0$.
2. Construct a quadrilateral MIST where MI = 3.5 cm, IS = 6.5cm, $\angle M = 75^0$, $\angle I = 105^0$ and $\angle S = 120^0$.

Miniatures of materials used in the lesson plan for teaching:

Arbawm (Chicken basket)



Suankual

Raw Chaicheh (A Bamboo Tongue)

Chaicheh (Tongue/Nippers/Pincers)

Lunglehkha (Slate)

Kho/Fawng (Square base small basket)

Suvel (Cotton Winding Machine)

Lesson Plan 6

Date : _____ Class : VIII

Section : _____ Period : _____

Duration: _____ Subject: _____

Unit : Data Handling Topic : Bar and Circular graphs

General Objectives:

To develop: -

1. Knowledge of students in data handling.
2. Understanding of imagination, reasoning, and observation
3. Scientific approach to mathematics in students.
4. Spatial ability and apply it in real life.
5. The understanding of the fundamentals of different types of graphs.

Learning Objectives (Specific):

After teaching the lesson, the learner will be able to

1. **Identify** the types of graphs used to arrange data
2. **Understand** how data is organized systematically.
3. **Solve** a data-based problem.
4. **Categorise** the grouping of data and grouped frequency tables.
5. **Develop** different types of graphs.

Process Skills/ Teaching Method:

- Explanation (with example), Demonstration, Heuristic, and Induction method.

Learning Resources: (TLM/ Teaching Aids)

1. Model: Belval, Darngun kual (spiral brass bangles), Lensuah, Ngotekherh, Emping (closed weave carrying basket), Paikawng (open weave carrying basket), Samkuih (traditional comb), Thul, Lunglehkha (slate)
2. Chart
3. Black/Whiteboard
4. Marker/chalk

Learner's Previous Knowledge

The students must have at least general knowledge of general surveys, government surveys, data, etc.

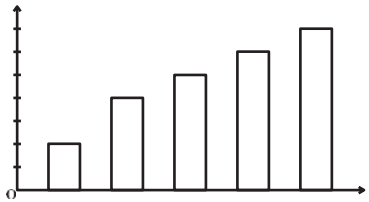
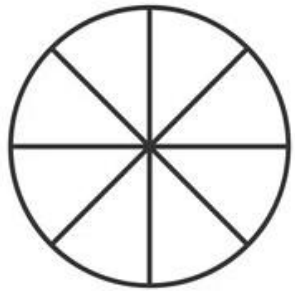
Introduction:

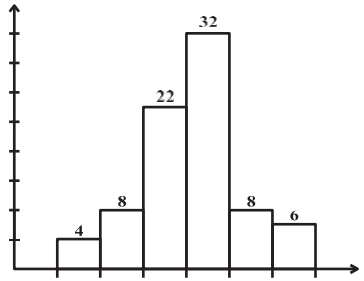
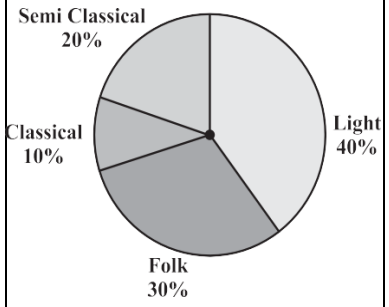
S. No.	Teacher's Activity	Student's Activity
1.	How do you think the government collects information about different things in our country?	By conducting a survey
2.	How is the survey performed?	By collecting data and information
3.	What is your understanding of data	Set of information
4.	Give some examples of data	Students' heights, favorite colors, marks in the exam, etc
5.	How many graphs do you know?	There are two types of graphs, bar graphs and circular graphs.

Statement of the Problem:

So, today we are going to study and discuss bar and circular graphs

Presentation:					
S. No.	**Teaching Point**	**5E component**	**Teachers' Activity**	**Students' activity**	**Black/white board work**
1.	Organising data	Engage	What is organising data? The teacher defines that organizing data involves systematically arranging raw data into a structured format to make it easier to read, analyze, and use.	No response Students will listen very carefully	
2.	Grouping data	Explore & Explain	The teachers ask for examples from daily life experiences. Based on your understanding, can you provide examples using cultural materials? The teacher emphasizes that mathematical activities like classifying, counting, and organizing. For instance, to make cultural materials such as Lensuah, Emping (open-weave carrying basket), Paikawng (open-weave carrying basket), Samkuih (traditional comb), etc, first we need to collect materials, and from	Students will answer: Students' heights, favourite colors, etc. No response. Students will pay attention.	

			that we need to prepare and separate them to make what we want.		
3.	Bar graphs	Explore & Explain	What do you understand by a bar graph? Very good. The teacher gives another definition as A bar graph is a visual tool that represents and compares data using rectangular bars of varying lengths or heights, which are proportional to the values they represent. Examples from our cultural materials can be Pher (bamboo mat board), Samkuih (traditional comb), etc.	Data is shown as a series of bars Students will listen very carefully	
4	Circular graphs	Explore & Explain	What do you understand by a circular graph? Circle graphs, also known as pie charts, are a visual way to display data using a circle divided into slices. Examples of circular graphs are Darngun kual (Spiral brass bangles), Belval, etc	No response	
			Qns: The number of hours for which students of a particular class watched television during holidays is shown through the given graph.		

5.	Numerical	Explain & Elaborate	Answer the following. (i) For how many hours did the maximum number of students watch TV? (ii) How many students watched TV for less than 4 hours? (iii) How many students spent more than 5 hours watching TV Ans: (i) 4-5 hours (ii) 34 students (iii) 14 students		
6.	Numerical	Explain & Elaborate	Qns: A survey was made to find the type of music that a certain group of young people liked in a city. The adjoining pie chart shows the findings of this survey. From this pie chart, answer the following: (i) If 20 people liked classical music, how many young people were surveyed? (ii) Which type of music is liked by the maximum number of people?		

			(iii) If a cassette company were to make 1000 CD's, how many of each type would they make? Ans: (i) classical = 10% So, classical music = 10 Let x be the no. young people survey. Therefore, 10% of x = 20 $\Rightarrow \frac{10}{100}x=20$ $\Rightarrow x = 20 \times 100/10 = 200$ So, 200 young people were surveyed. (ii) Light Music is liked by the maximum number of people. (iii) Total number of cassettes made = 1000 Classical music = 10% of 1000 =100 Semi-classical = 20% of 1000 = 200 Folks = 30% of 1000 = 300 Light music = 40%1000 = 400		
Closer Statement:					
So, today we have learned about the Bar and Circular graphs.					
Assessment:					
1. The weekly wages (in ₹) of 30 workers in a factory are.					

830, 835, 890, 810, 835, 836, 869, 845, 898, 890, 820, 860, 832, 833, 855, 845,
804, 808, 812, 840, 885, 835, 835, 836, 878, 840, 868, 890, 806, 840

Using tally marks make a frequency table with intervals as 800–810, 810–820 and so on.

2. Draw a histogram for the frequency table made for the data in Question 1, and answer the following questions.
   (i) Which group has the maximum number of workers?
   (ii) How many workers earn ₹ 850 and more?
   (iii) How many workers earn less than ₹ 850?

3. A group of 360 people were asked to vote for their favourite season from the three seasons rainy, winter and summer.
   (i) Which season got the most votes?
   (ii) Find the central angle of each sector.
   (iii) Draw a pie chart to show this information.

Season	No. of votes
Summer	90
Rainy	120
Winter	150

Recapitulation:

1. Organising data
2. Grouping data
3. Bar graphs
4. Circular graph

Home Assignment:

1. Draw a pie chart showing the following information. The table shows the colours preferred by a group of people

Colours	Number of people
Blue	18
Green	9
Red	6
Yellow	3
Total	**36**

2. For which of these would you use a histogram to show the data?

(a) The number of letters for different areas in a postman's bag.

(b) The height of competitors in athletics meet.

(c) The number of cassettes produced by 5 companies.

(d) The number of passengers boarding trains from 7:00 a.m. to 7:00 p.m. at a station.

Give reasons for each.

Miniatures of materials used in the lesson plan for teaching:

Paikawng (open weave carrying basket)

Belval

Ngotekherh

Lensuah

Darngun Kual (Spiral Brass Bangles)

Samkuih (Traditional Comb)

Pher (Mizo bamboo mat board)

Lesson Plan 7

Date : _____ Class : VIII

Section : _____ Period : _____

Duration: _____ Subject: _____

Unit : Data Handling Topic : Chance and Probability

General Objectives:

To develop: -

1. Knowledge of students in data handling.
2. Understanding of outcomes of an event.
3. Scientific approach to mathematics in students.
4. Spatial ability and apply it in real life.
5. The understanding of the fundamental concept of probability.

Learning Objectives (Specific):

After teaching the lesson, the learner will be able to

1. **Describe** the chances and probability.
2. **Understand** how chances can occur.
3. **Solve** a probability-based problem.
4. **Categorise** the different types of probability problems.
5. **Design** a chance and probability-based problem.

Process Skills/ Teaching Method:

- Explanation (with example), Demonstration, Heuristic, and Induction method.

Learning Resources: (TLM/ Teaching Aids)

1. Model: Saihlum (pellet), Baibel (Earthen pot), Emping (Closed wave carrying basket), Paikawng (Open wave carrying basket), Thul (Storage basket), Kho/Fawng (Square base small basket), Arbawm (Chicken basket), Suvel (Cotton winding machine), Chhihri (Sieve),
2. Chart
3. Black/Whiteboard
4. Marker/chalk

Learner's Previous Knowledge

The students are familiar with the basic concepts of chance, organising data, grouping data, bar graphs, and circular graphs.

Introduction:

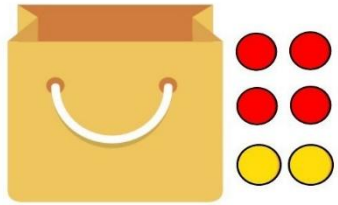
S. No.	Teacher's Activity	Student's Activity
1.	What do you understand by the word 'chance'?	A possibility of something happening.
2.	Can you give examples?	For example, "There is a chance of rain today."
3.	What do you understand by probability?	It can be defined as the "chance of happening an event," with values always ranging from (0) (impossible) to (1) (certain)
4.	Can you give examples?	Tossing a coin, rolling a die, drawing from a bag, etc.
5.	Do you think it is applicable in real life?	Yes, it is applicable in real life situation

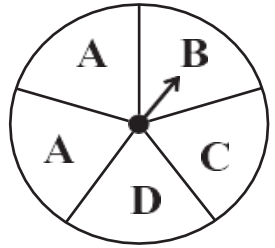
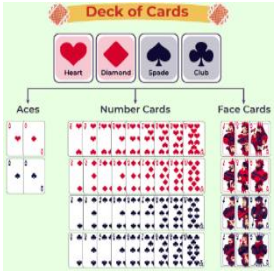
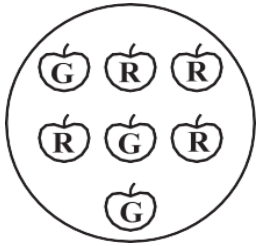
Statement of the Problem:

So, today we are going to study and discuss chance and probability.

Presentation:					
S. No.	**Teaching Point**	**5E component**	**Teachers' Activity**	**Students' activity**	**Black/white board work**
1.	Linking chance to probability	Engage and Explain	What do we understand by linking chance to probability? The teacher tries to explain by giving a suitable example. Consider the experiment of tossing a coin once. What are the outcomes? There are only two outcomes – Head or Tail. Both the outcomes are equally likely. Likelihood of getting a head is one out of two outcomes, i.e., 1/2. In other words, we say that the probability of getting a head = 1/2. What is the probability of getting a tail? Now take the example of throwing a die marked with 1, 2, 3, 4, 5, 6 on its faces (one number on one face). If you throw it once, what are the outcomes? The outcomes are: 1, 2, 3, 4, 5, 6. Thus, there are six equally likely outcomes. What is the probability of getting the outcome '2'?	No response. Students listen very carefully. Students try to understand	

			It is 1/6, since the total is 6 and the outcome is 1. What is the probability of getting the number 5? What is the probability of getting the number 7? What is the probability of getting a number 1 through 6?		
2	Chance and probability related to real life	Engage and Explain	Do you think chance and probability are related to real life? Let's try to give examples for better understanding. We talked about the chance that it rains just on the day when we do not carry a raincoat. What could you say about the chance in terms of probability? Could it be one in 10 days during the rainy season? The probability that it rains is then 1/10. The probability that it does not rain =9/10. (Assuming raining or not raining on a day is equally likely). Now, let's try to think from a cultural materials perspective, that we know Saihlum (Pellet) and Baibel (Earthen pot) are made of clay, it can be	Yes Students listen very carefully.	

			found that the probability of making pellets (in number) from Earthen pots. Likewise, probability can arise in different cultural materials made from bamboo, wood, etc.		
3.	Numerical	Elaborate and Explain	Qns: A bag has 4 red balls and 2 yellow balls. (The balls are identical in all respects other than colour). A ball is drawn from the bag without looking into the bag. What is the probability of getting a red ball? Is it more or less than getting a yellow ball? Ans: There are in all (4 + 2 =) 6 outcomes of the event. Getting a red ball consists of 4 outcomes. (Why?) ∴ The probability of getting a red ball is 4/6=2/3. In the same way, the probability of getting a yellow ball = 2/6 = 1/3 ∴ The probability of getting a red ball is more than getting a yellow ball.	Students will respond by saying that the question is the probability of getting a red ball	
			Find the. (i) Probability of the pointer stopping on D.		

4.	Numerical	Elaborate and Explain	(ii) Probability of getting an ace from a well-shuffled deck of 52 playing cards? (iii) Probability of getting a red apple. Ans: (i) The pointer can stop at one of the following region A,A,B,C,D Out of these 5 cases, it is possible only in 1 case that the pointer will stop at region D. ∴ Probability that the pointer will stop at region D=1/5 (ii) There are 52 cards in a deck of cards and there are 4 aces cards in a deck of cards. ∴ Probability of getting an ace= 4/52=1/13 (iii) There are a total of 7 apples, out of which 4 are red and 3 ae green. ∴ Probability of getting a red appe=4/7		  
Closer Statement: So, today we have learned about chance and probability					

Assessment:

1. When a die is thrown, list the outcomes of an event of getting
   (i) prime number (ii) not a prime number.
   (iii) a number greater than (iv) number not greater than 5.
2. Find the probabilities of the events given in Question 1.

Recapitulation:

1. Linking chance to probability
2. Outcomes of an events
3. Chance and probability related to real life

Home Assignment:

1. Numbers 1 to 10 are written on ten separate slips (one number on one slip), kept in a box and mixed well. One slip is chosen from the box without looking into it. What is the probability of
   (i) getting a number 6?
   (ii) getting a number less than 6?
   (iii) getting a number greater than 6?
   (iv) getting a 1-digit number?
2. If you have a spinning wheel with 3 green sectors, 1 blue sector, and 1 red sector, what is the probability of getting a green sector? What is the probability of getting a non-blue sector.

Miniatures of materials used in the lesson plan for teaching:

Arbawm (Chicken basket)

Paikawng (Open wave carrying basket)

Thul (storage basket)

Thlangra (Winnowing tray)

Pher (Mizo bamboo mat board)

Kho/Fawng (Square base small basket)

Saihlum (pellet)

Baibel (Earthen pot)

Lesson Plan 8

Date : _____ Class : VIII

Section : _____ Period : _____

Duration: _____ Subject: _____

Unit : Visualising Solid Shapes Topic : Views of 2-D and 3-D figures

General Objectives:

To develop

1. Knowledge about the views of 2-D and 3-D figures
2. The concept of solid shapes
3. Reasoning ability in mathematics
4. Intellectual level of students
5. Ability to sense a problem

Learning Objectives (Specific):

After teaching the lesson, the learner will be able to: -

1. **Identify** various solid shapes that they use in daily life.
2. **Compare** 2-D and 3-D figures.
3. **Examining** the top view, front view, and side view of solid shapes.
4. **Correlate** drawing skills and creativity.
5. **Develop** constructive imagination and interest, and show interest in learning geometry.

Process Skills/ Teaching Method:

- Explanation (with example), Demonstration, Heuristic, and Induction method.

Learning Resources: (TLM/ Teaching Aids)

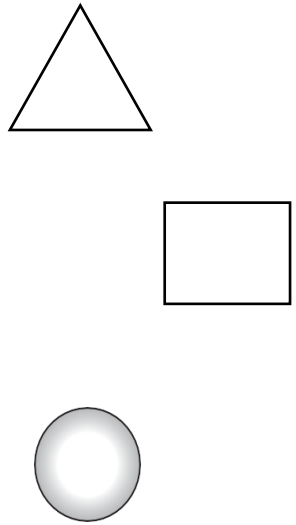
1. Model: Chhemthei, Herhsawp (Mizo stool), Ipte pui (Mizo traditional bag), Kho (square base small basket), Tawtawrawt (Bamboo trumpet), Vaibel (smoking pipe), Pher (Mizo bamboo mat board), Mizo in (Typical Mizo house).
2. Chart
3. Black/Whiteboard
4. Marker/chalk

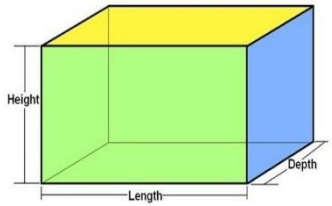
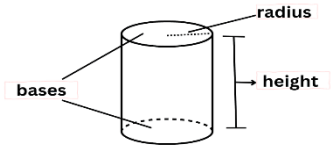
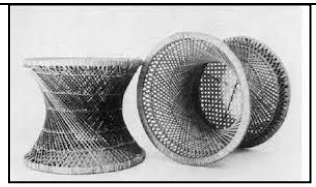
Learner's previous knowledge

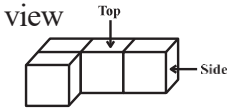
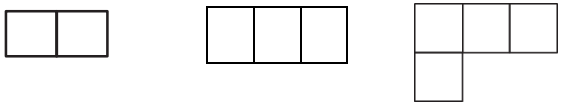
To learn this lesson, students should be familiar with geometrical shapes and basic geometrical concepts.

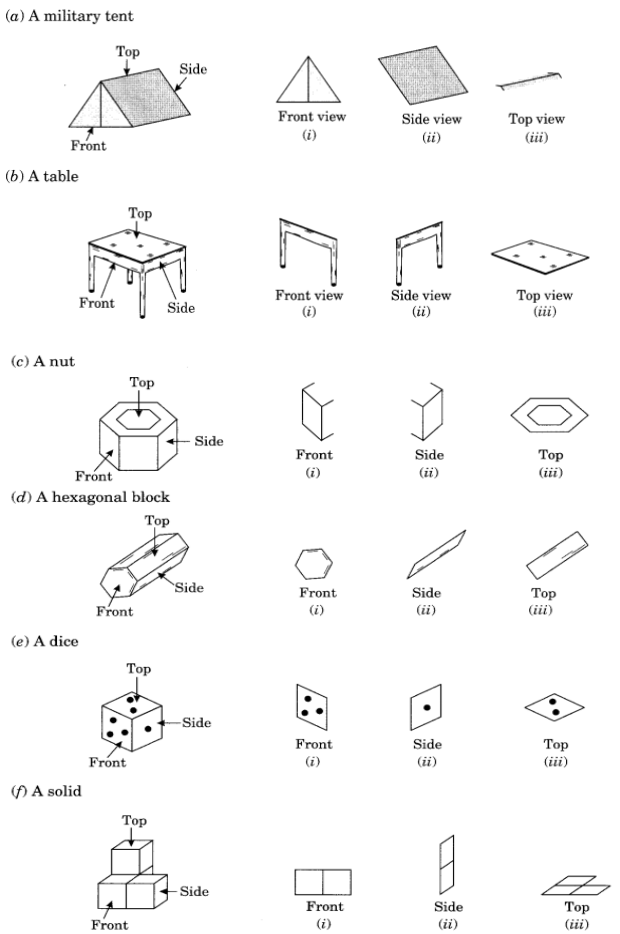
Introduction:

S. No.	Teacher's Activity	Student's Activity
1.	Students, please name a few things that are solid around us.	Table, chair, lectern, board, box, etc
2.	Do you think that they have something in common?	Yes, they have length, breadth, height, etc
3.	What do you understand by 2-D and 3-D figures?	A plane figure with two dimensions is called a 2-D shape, whereas an object that occupies space and has three dimensions is called a 3-D shape.
4.	Please give examples of 2-D and 3-D figures.	2-D figures are circles, squares, rectangles, triangles, etc 3-D figures are spheres, cones, cylinders, etc
5.	Give a model example of 2-D and 3-D from Mizo cultural material.	Pher (Mizo bamboo mat board), Belval, Saihlum(pellet), Kho/Fawng (square base small basket), Chhemthei, Kahpuk (Bamboo toy gun),

			Chingal Thlawrbel (Leaching funnel), Thlangra (winnowing tray), etc.		
Statement of the Problem:					
So, today we will study and discuss the views of 2-D and 3-D.					
Presentation:					
S. No.	**Teaching Point**	**5E component**	**Teachers' Activity**	**Students' activity**	**Black/white board work**
1.	2-Dimension	Engage and Explore	What is a two-dimensional figure? The teacher explained and defined that a 2D (Two-Dimensional) figure is a flat shape with only length and width, such as a circle or a square, which can be drawn on a surface but lacks thickness or depth. Do we all understand? Can you give an example? Yes correct. The teacher mentions and shows the different Mizo materials of 2-D shapes, such as Triangle is Thlangra (Winnowing tray) Square is Pher (Bamboo mat board).	No response Students listen very carefully Yes sir Students' responses include shapes like squares, triangles, circles, etc.	
2.			How do we understand a 3-D figure?	No response	

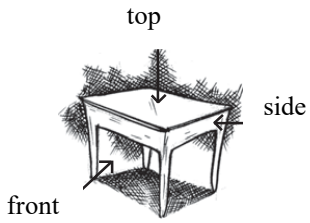
	3-Dimension	Engage and Explore	(Three-Dimensional) Figures are solid, three-dimensional objects that have length, width, and height (or depth), occupy space, and can be physically held, such as a cube or a sphere. Can you give an example? The teacher appreciates the learner and gives more examples and shows the Mizo cultural Material such as Chhemthei, Herhsawp (Mizo stool), Ipte pui (Mizo traditional bag), Kho (square base small basket), and a bamboo toy gun.	Students will listen very carefully. Cylinder, cone, cuboid, etc. Students look at the model and observe.	  A cylinder
3	Views of 2-D	Engage and Explore	The teacher explained that two-dimensional (2D) views are flat, two-dimensional representations of an object, characterized by having length and width but no depth. Examples of 2-D are Thlangra (Winnowing tray), which is a triangle, and Pher (Bamboo mat board) is Square/rectangular.	Students will pay attention and listen very carefully	 Square Bamboo mat board
4.	Views of 3-D	Engage and Explore	The teacher also explained that a 3-dimensional (3D) view describes an object that has height, width, and depth, allowing it to take up volume	Students will pay attention and listen very carefully	

			and have a sense of solidity, unlike flat 2-dimensional shapes Examples are Herhsawp (Mizo stool), Ipte pui (Mizo traditional bag), Kho (square base small basket), and a bamboo toy gun.		
5	Numerical	Elaborate and Evaluate	Qns: For the given solid, identify the top view, front view, and side view  front  (i) (ii) (iii) Ans: (i) Side (ii) Front (iii) Top	Students look and listen very carefully	
			Qns: Draw the front view, side view, and top view of the given objects		

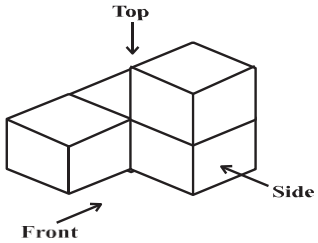
6	Numerical	Elaborate and Evaluate		Students look and listen very carefully	
Closer Statement:					
So, today we have learned about the Views of 2-D and 3-D figures					

Assessment:

1. Draw the front view, side view, and top view of the given object.



2. For the given solid, identify the top view, front view, and side view.

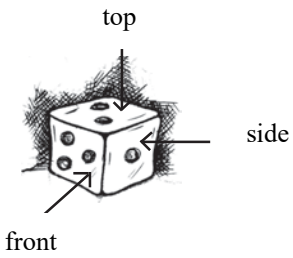


Recapitulation:

1. Meaning of
   a. 2-D
   b. 3-D
2. Views of
   a. 2-D
   b. 3-D

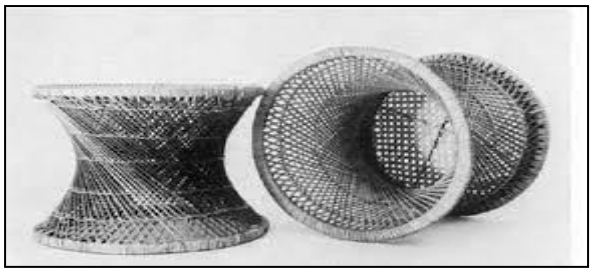
Home Assignment:

1. Draw the front view, side view, and top view of the given object.



Miniatures of materials used in the lesson plan for teaching:

Chhemthei



Herhsawp (Mizo stool)

Kho /Fawng (square base small basket)

Kahpuk (bamboo toy gun)

Vaibel (smoking pipe)

Pher (bamboo mat board)

Tawtawrawt (Bamboo Trumpet)

Lesson Plan 9

Date : _____ Class : VIII

Section : _____ Period : _____

Duration: _____ Subject: _____

Unit : Visualising solid shapes Topic : Faces, edges and vertices of 3-D figures.

General Objectives:

To develop

1. Knowledge about the Faces, edges, and vertices
2. The concept of 3-D figures
3. Reasoning ability in mathematics
4. Intellectual level of students
5. Ability to sense a problem

Learning Objectives (Specific):

After teaching the lesson, the learner will be able to: -

1. **Identify** faces, edges, and vertices
2. **Classify** faces, edges, and vertices
3. **Examining** Euler's formula.
4. **Correlate** drawing skills and creativity.
5. **Develop** constructive imagination and interest, and show interest in learning geometry.

Process Skills/ Teaching Method:

- Explanation (with example), Demonstration, Heuristic, and Induction method.

Learning Resources: (TLM/ Teaching Aids)

1. Model: Aiawt (Crab trap), Chingal Thlawrbel (Leaching funnel), Mizo In (Typical Mizo house), Tap (Fire place), Arbawm (Chicken basket), Tuium (Mizo water bottle), Chhemthei.
2. Chart
3. Black/Whiteboard
4. Marker/chalk

Learner's previous knowledge

To learn this lesson, students should be familiar with geometrical shapes and basic geometrical concepts. Also, students should be aware of the side, top, and front views of 2-D and 3-D figures.

Introduction:

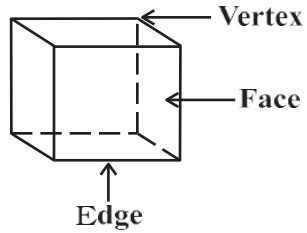
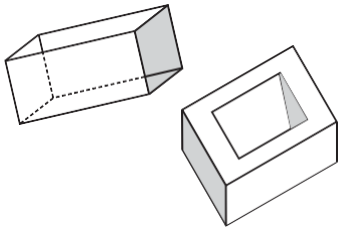
S. No.	Teacher's Activity	Student's Activity
1.	Students, please name a few things that are solid around us.	Table, chair, lectern, board, box, etc
2.	Do you think that they have something in common?	Yes, they have length, breadth, height, etc
3.	What do you understand by 2-D and 3-D figures?	A plane figure with two dimensions is called a 2-D shape, whereas an object that occupies space and has three dimensions is called a 3-D shape.
4.	Please give examples of 2-D and 3-D figures.	2-D figures are circles, squares, rectangles, triangles, etc 3-D figures are spheres, cones, cylinders, etc

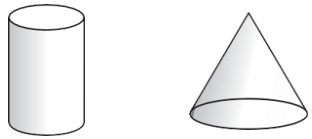
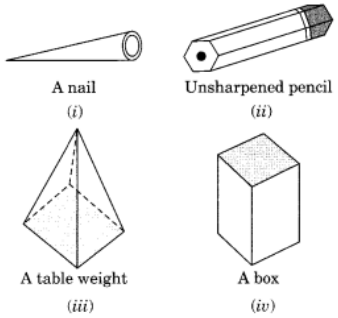
5.	Are we familiar with faces, edges, and vertices in solid shapes?	Yes

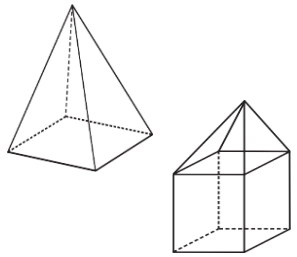
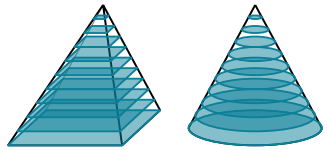
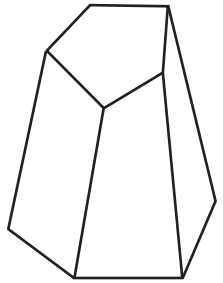
Statement of the Problem:

All right, today we are going to study and discuss the faces, edges, and vertices of 3-D figures.

Presentation:

S. No.	Teaching Point	5E component	Teachers' Activity	Students' activity	Black/white board work
1.	Vertex, Face, Edge	Engage and Explore	Are we familiar with the vertex, face, and edge? The teacher explains and gives the definitions that a **vertex** is a point where edges meet (a corner), a **face** is a flat or curved surface of a 3D shape, and an **edge** is a line segment where two faces meet. The teacher gives an example from cultural materials having vertex, face, edge, such as Mizo In (Typical Mizo house), Tap (Fire place).	No response Students will listen very carefully.	
2.	Polyhedrons	Engage and Explore	What is a polyhedron? The teacher gives the definition and explains with the help of examples that each of these solids is made up of polygonal regions, which are called its faces; these faces meet at edges, which are line		

			segments; and the edges meet at vertices, which are points. Such solids are called polyhedrons. Examples of polyhedron from cultural materials are Mizo In (Typical Mizo house), Tap (Fire place), whereas non polyhedron are Tuium (Mizo water bottle) and Chhemthei.		
3	Numerical	Elaborate and Evaluate	Qns: Which are prisms among the following?  Solution: Only (ii) unsharpened pencil and (iv) a box are the prism.		

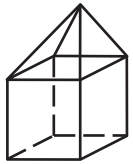
4.	Numerical	Elaborate and Evaluate	Qns: Can a polyhedron have for its faces? i) 3 triangles ii) 4 triangles iii) A square and four triangles Ans: i) No, it's not possible ii) yes iii) yes		
5.	Numerical	Elaborate and Evaluate	How are pyramids and cones alike? Ans: The teacher will explain and conclude that a pyramid becomes a cone as the number of sides of its base becomes larger and larger		
5.	Numerical	Elaborate and Evaluate	Qns: Verify Euler's formula for these solids Ans: From the given figure, Number of vertices=10 Number of faces=7 Number of edges=15 Then, according to Euler's formula, F+V-E=2 7+10-15=2, which is verified		

Closer Statement:

So, today we have learned about the faces, edges, and vertices of 3-D figures.

Assessment:

1. Can a polyhedron have 10 faces, 20 edges, and 15 vertices?
2. Verify Euler's formula for the given solid.



Recapitulation:

1. Meaning and views of 3-D figures in terms of
   a) faces,
   b) edges, and
   c) vertices

Home Assignment:

1. Using Euler's formula, find the unknown.

Faces	?	5	20
Vertices	6	?	12
Edges	12	9	?

Aiawt (crab trap)

Chingal Thlawrbel (leaching funnel)

Arbawm (chicken basket)

Mizo In (typical Mizo house)

Chhemthei

Tuium (Mizo water bottle)

Tap (fire place)

Lesson Plan 10

Date : _____ Class : VIII

Section : _____ Period : _____

Duration: _____ Subject: _____

Unit : Mensuration Topic : Area and Perimeter of 2-D shapes

General Objectives:

To develop:

1. Knowledge of 2-D shapes and figures
2. Understanding of the concept of areas and perimeters of 2-D shapes and figure
3. The basis for mathematical skills that will be needed in daily life situations.
4. Skills in accuracy and problem-solving.
5. Interest in learning mathematics

Learning Objectives (Specific):

After teaching the lesson, the learner will be able to:

1. **Recognise** different 2-D shapes and figure
2. **Classify** formulae and use them in finding areas and perimeters of 2-D shapes
3. **Solve** the problem of finding the areas and perimeters of 2-D shapes
4. **Distinguish** the area and perimeter of 2-D figures
5. **Develop** techniques and skills in calculation

Process Skills/ Teaching Method:

- Explanation (with example), Demonstration, Heuristic, and Induction method.

Learning Resources: (TLM/ Teaching Aids)

1. Model: Pher (Bamboo mat board), Belval, Emping (Closed wave carrying basket), Paikawng (Open wave carrying basket), Thul (Storage basket), Kho/Fawng (Square base small basket), Lunglehkha (slate).
2. Chart
3. Black/Whiteboard
4. Marker/chalk

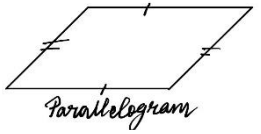
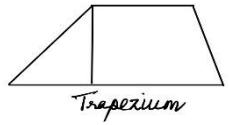
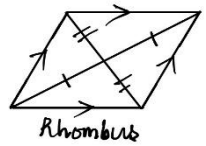
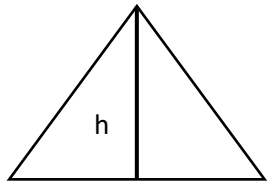
Learner's previous knowledge

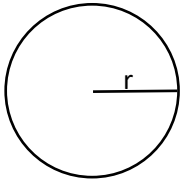
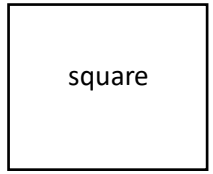
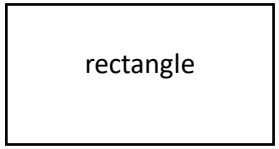
The students are familiar with the basic concepts of rectangle, square, triangle, parallelogram, trapezium, and circle.

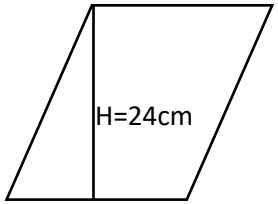
Introduction:

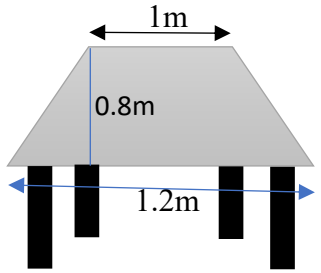
S. No.	Teacher's Activity	Student's Activity
1.	Do you know a square, a rectangle, and a parallelogram?	Yes,
2.	Can you differentiate between a square, a rectangle, and a parallelogram?	A square is all sides equal and the diagonal is equal to 90^0, a rectangle is opposite sides and the diagonal is equal to $90^{0,}$ whereas in a parallelogram, opposite sides are equal and parallel, but diagonals are not equal
3.	Are we all familiar with a triangle?	Yes, A triangle is a three-sided polygon
4.	Can you give a simple example of a circle from Mizo materials?	Belval, Chhemthei.
5.	Are they all 2-D or 3-D shapes?	2-D shapes

Statement of the Problem:					
So, today we are going to study and discuss the Area and Perimeter of 2-D shapes					
Presentation:					
S. No.	**Teaching Point**	**5E component**	**Teachers' Activity**	**Students' activity**	**Black/white board work**
1.	Area and Parmeter	Engage and Explain	The teacher asks about the general meaning of area and perimeter. Yes, well done it is correct. Area is the total space taken by the two-dimensional object. Whereas, the perimeter is the total length of the boundary. In a circle, it is called the circumference.	Area is a measurement of size and perimeter is a boundary.	
2.	Square and Rectangle	Explore and Explain	The teacher asks, are we all familiar with a rectangle and square? Can you name any Mizo material having square and rectangular shapes? Do you know the formula for finding the area and perimeter of a square and a rectangle? Area: Rectangle = l x b	Students will respond by saying 'Yes' Square: base of Emping, Paikawng, Thul, Kho/Fawng, Rectangle: Pher (Bamboo mat	 Square

			Square = $(side)^2 = a^2$ Perimeter: Rectangle = 2(l+b) Square = 4a	board), Lunglehkha (slate)	 Rectangle
3.	Parallelogram Trapezium Rhombus	Explain	The teacher asks the students whether they know about parallelograms, trapezium, and rhombus. Alright, do you the formula for finding the area of a parallelogram and trapezium? Area of parallelogram = b x h Area of trapezium = $\frac{1}{2}$ h (a+b) Area of rhombus = $\frac{1}{2}\, d_1 d_2$	Yes, we already studied Chapter 3 Students will listen very carefully	  
3	Triangle	Engage and Explain	The teacher recalls a triangle by asking the formula for finding the area of and triangle. Can you give an example of a triangle?	Are = $\frac{1}{2}.b.h$ Thlangra (Winnowing tray), Lensuah.	
4.	Circle	Explain	The teacher believes that all the learners will be aware of the circle and raise a question, Are we all familiar with a circle?	Yes	

			Do you know the formula for finding the area and circumference of a circle? Area of circle =πr^2 Circumference of circle = $2\pi r$ Can you name any circular material from Mizo materials? The teachers give a few materials such as Belval, Darngun kual, Vaihrik, etc.	Students will listen very carefully Students will discuss	
5.	Numerical	Explain and Evaluate	Qns. A square and a rectangular field with measurements as given in the figure have the same perimeter. Which field has a larger area? Ans: Given side of a square = 60m Length of a rectangle = 80 m We have, Perimeter of rectangle= perimeter of square. Do we still remember the formula, We have, 2(l+b) = 4a $\Rightarrow$ 2 (80+b) = 4x60 $\Rightarrow$ 80 +b =120 $\Rightarrow$ b = 40 m	Students will respond by saying the formula	 Side = 60m  l=80m

			Then, the area of square = a^2=40x40=1600m^2 And, area of rectangle = lxb =80x40 = 3200m^2 ∴ A square has a larger area.		
6.	Numerical	Explain and Evaluate.	Qns. A floor tile has the shape of a parallelogram whose base is 24cm and the corresponding height is 10cm. How many such tiles are required to cover a floor of an area of 1080 m^2? Ans: Given an area of floor = 1080m^2 Also, base of parallelogram = 24cm = 24/100m And, height of parallelogram=10cm=10/100m Since the area is given in metre, we need to convert it into metre (m). The teacher asks, do we remember the formula for finding the area of a parallelogram? We have, No. of tiles required = $\frac{Area\ of\ floor}{Area\ of\ parallelogram}$ $= \frac{1080}{.24X.1}$ $= \frac{1080}{0.024}$	Students will look at the board and listen carefully. Students provide the answer by saying base multiple height	Area = 1080m^2  B =10cm

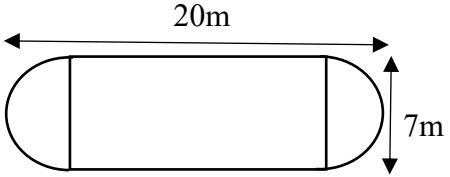
			= 45000 ∴ No of tiles required is 45000.		
7.	Numerical	Explain and Evaluate.	Qns. The shape of the top surface of a table is a trapezium. Find its area if its parallel sides are 1. And 1.2m and the perpendicular distance between them is o.8m. Ans: Given, parallel sides of a table = 1m and 1.2 m and the distance between them = 0.8m After explaining using the picture model and diagram from the board, The teacher asks, can we recall the area of a trapezium? Area of trapezium = ½ x (sum of // sides) x (distance between them) = ½ x (1+1.2) x 0.8 = ½ x 2.2 x 0.8 = 0.88 m^2 ∴ The area of the trapezium is 0.88 m^2	The student will respond by saying the formula.	

Closer Statement:

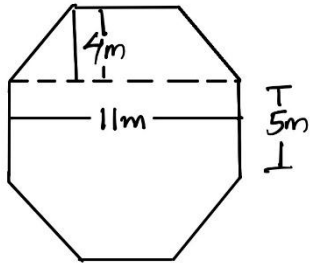
So, today we have learned about the area and perimeter of 2-D shapes.

Assessment:

1. The shape of a garden is rectangular in the middle and semi-circular at the end as shown in the diagram. Find the area and perimeter of a diagram.



2. The diagonal of a rhombus is 7.5cm and 12 cm. Find its area
3. The top surface of a raised platform is in the shape of a regular octagon as shown in the figure Find the area of the octagonal surface.

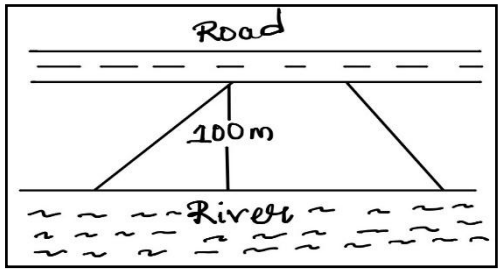


Recapitulation:

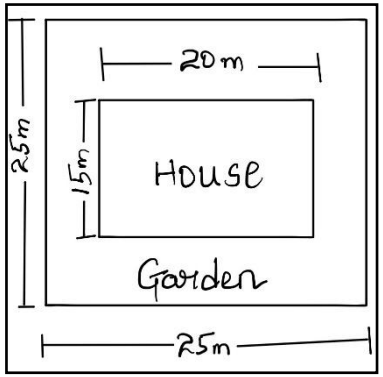
1. Area and perimeter of
   a. Square and Rectangle
   b. Parallelogram Trapezium
   c. Rhombus
   d. Triangle
   e. Circle

Home Assignment:

1. Mohan wants to buy a trapezoidal-shaped field, its side along the river is parallel to and twice the side along the road. If the area of this field is 10500m^2 and the perpendicular distance between the two parallel sides is 100m, find the length of the side along the river.



2. Mrs. Kaushik has a square plot with the measurement as shown in the figure. She wants to construct a house in the middle of a plot. A garden is developed around the house. Find the total cost of developing a garden around the house at the rate of 55 per m^2.



Miniatures of materials used in the lesson plan for teaching:

Belval

Paikawng (Open wave carrying basket)

Thul (storage basket)

Thlangra (Winnowing tray)

Pher (Mizo bamboo mat board)

Kho/Fawng (Square base small basket)

Lunglehkha (Slate)

Lensuah

Lesson Plan 11

Date : _____ Class : VIII

Section : _____ Period : _____

Duration: _____ Subject: _____

Unit : Mensuration Topic : Surface area of cube, cuboid and cylinder

General Objectives:

To develop: -

1. Knowledge about 3-D shapes and figures
2. Understanding of the concept of the surface area of a cube, cuboid, and cylinder.
3. Mathematical skills which will be needed in daily life situations
4. Skills in accuracy and problem-solving
5. Interest in learning mathematics

Learning Objectives (Specific):

After teaching the lesson the learner will be able to: -

1. **Recall** different 3-D shapes and figure
2. **Classify** formulae used in finding the lateral and total surface area of a cube, cuboid, and cylinder.
3. **Solve** the problem based on lateral and total surface area.
4. **Relate** the lateral and total surface area of a cube, cuboid, and cylinder.
5. **Develop** techniques and skills in calculation.

Process Skills/ Teaching Method:

- Explanation (with example), Demonstration, Heuristic, and Induction method.

Learning Resources: (TLM/ Teaching Aids)

1. Model: Chhemthei, Herhsawp (Mizo stool), Ipte pui (Mizo traditional bag), Kho (square base small basket), Tapchhak, Tawtawrawt, Vaibel)
2. Chart
3. Black/Whiteboard
4. Marker/chalk

Learner's previous knowledge

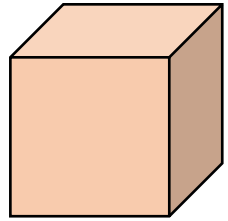
The students must be familiar with the basic concepts of cube, cuboid, and cylinder.

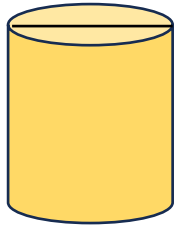
Introduction:

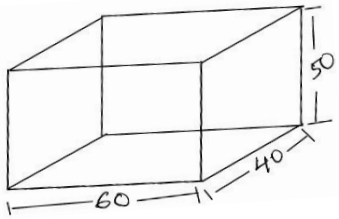
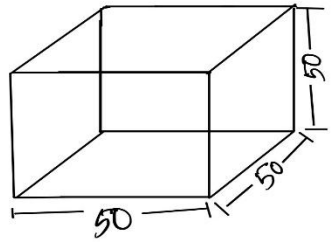
S. No.	Teacher's Activity	Student's Activity
1.	Are we all familiar with cubes and cuboids?	Yes
2.	What are the dissimilarities?	In a cube, all sides are equal whereas a cuboid does not.
3.	Name a few examples of cube or cuboidal shapes that we use and see in daily life.	Building structure, rubric cube, truck body, aquarium, parcel, etc.
4.	Do you know a cylinder?	Yes
5.	Can you please give an example of a cylinder that we use in day-to-day life?	Pencil, gas cylinder, syntax (water tank), chalk, etc

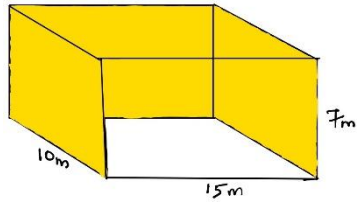
Statement of the Problem:

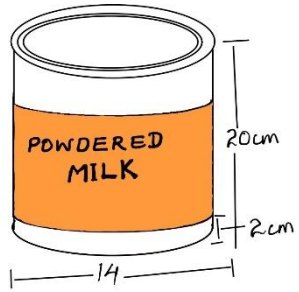
So, today we are going to learn and talk about the Surface area of a Cube, Cuboid, and Cylinder.

Presentation:					
S. No.	**Teaching Point**	**5E component**	**Teachers' Activity**	**Students' activity**	**Black/white board work**
1.	Cube		The teacher asks a student about a cube. Very good, thank you. Cubes are very common and useful in real-life situations that we can see and unused in every corner of the workplace, home, etc. An example of a cube from Mizo cultural materials is Thlam (Jhum hat). As mentioned, cubes have equal length, breadth, and height. The total surface area of a cube = $6a^2$ Whare as lateral or curves surface area means excluding the top and bottom, Therefore, we have Curved surface/lateral surface area = $4a^2$	A cube is a three-dimensional object having 6 faces, 8 vertices, and 12 edges of equal length. Students will listen very carefully.	
2.	Cuboid		The teacher tries to recall students' knowledge by asking a cuboid?	Unlike a cube, cuboids have unequal sides.	

			Cuboids are also very useful in daily life. Also, we have a few cuboidal structures in Mizo cultural materials such as Kho (square base small basket), Ipte Pui (Mizo traditional bag), typical Mizo house. Here is the formula for finding The total surface area of a cuboid = 2 (lb+bh+hl) Curved surface area of cuboid = 2h (l+b) Where, h= height, l= length, b= breadth.	Students will pay attention to what the teacher is saying.	
3	Cylinder		The teacher asks, are we all aware of a cylinder? Can you please define a cylinder? A cylinder is a fixed-distance 3-D solid consisting of two parallel bases connected by a curving surface. A few examples of cylinders from Mizo cultural materials are as follows: Chhemthei Herhsawp (Mizo stool) Kahpuk (Bamboo toy gun) Vaibel (Smoking pipe) Tawtawrawt (Bamboo Trumpet)	Yes no answer students will listen very carefully.	

			Formula for finding Total surface area = $2\pi r(r+h)$ Curved surface area = $2\pi rh$		
4.	Numerical		Qns: There are two cuboidal boxes as shown in the figure. Which box requires a lesser amount of material of material to make? Ans: From the figure (a), l=60 cm, b=40 cm, h=50 cm. Do you remember the formula for finding the total surface area of a cube and cuboid Total surface area of cuboid = 2 (lb+bh+hl) = 2 (60x40 +40x50+50x60) = 2 (7400) = 14800 cm^2 From fig (b), side of square = 50 cm The total surface area of a cube = $6a^2$ = $6x(50)^2$ = 15000 cm^2 We can notice that the cuboid has less surface area. ∴ Cuboid requires less amount of material to make.	Students will say the formula	 

5.	Numerical		Qns: Daniel is painting the wall and ceiling of a cuboidal hall with length, breadth, and height of 15m,10m, and 7m respectively. From each can of paint 100 m^2 of area is painted. How many cans of paint will she need to paint the room? Ans: Given, l=15m, b=10m, h=7m Here, Daniel is painting the wall and the ceiling, do we have any idea what formula to use? We have, Area to be painted = 2h(l+b) + (lxb) = 2 x7(15+10) + (15x10) = 14 (25) + (150) = 500 m^2 For 100m^2 of area, can used = 1 Foe 1m^2 of area, can used = 1/100 ∴ for 500m^2 of area, can used = $\frac{1}{100}$ X 500 = 5 cans	We need to combine the surface area and the area of a rectangle	
6.	Numerical		Qns: A company packages its milk powder in a cylindrical container whose base has a diameter of 14cm and a height of 20cm. The company		

			places a label around the surface of a container (as shown in the figure). If the label is placed 2cm from the top and bottom, what is the area of the label? Ans: From the diagram, we have h= 20-2-2=16 cm. Do you remember the formula? Curved surface area of a cylinder (label)= $2\pi rh$ = 2x22x7x16 /7 = 704 cm^2.	Students will say the formula	

Closer Statement:

So, today we have learned about the surface area of a cube, cuboid, and cylinder.

Assessment:

1. Find the side of a cube whose surface area is 600 cm^2.
2. The internal measurements of a cuboidal room are 12m X 8m X 4m. Find the total cost of whitewashing all four walls of a room, if the cost of whitewashing is Rs 5 per square metre. What will be the cost of whitewashing if the ceiling of the room is also whitewashed?
3. A road roller takes 750 complete revolutions to move once over to level a road. Find the area of the road if the diameter of a road roller is 84 cm and the length is 1m.

Recapitulation:
1. Meaning and calculation of total surface area and surface area of a) Cube b) Cuboid c) Cylinder
Home Assignment:
1. The lateral surface area of a hollow cylinder is 4224 cm^2. It is cut along its height and forms a rectangular sheet of width 33cm. find the perimeter of a rectangular sheet. 2. Rukshar painted the outside of the cabinet to measure 1m X 2m X 1.5m. How much surface area did she cover if she painted all except the bottom of the cabinet.

Miniatures of materials used in the lesson plan for teaching:

Belval

Paikawng (Open wave carrying basket)

Thul (storage basket)

Thlangra (Winnowing tray)

Pher (Mizo bamboo mat board)

Kho/Fawng (Square base small basket)

Lesson Plan 12

Date : _____	Class : VIII
Section : _____	Period : _____
Duration: _____	Subject: _____
Unit : Mensuration	Topic : Volume of a cube, cuboid and cylinder.

General Objectives:

To develop: -

1. Knowledge about 3-D shapes and figures
2. Basic understanding of the concept of the volume of a cube, cuboid, and cylinder.
3. Mathematical skills that will be needed in daily life situations
4. Skills in accuracy and problem-solving
5. Interest in learning mathematics

Learning Objectives (Specific):

After teaching the lesson, the learner will be able to: -

1. **Recognise** different 3-D shapes and figures
2. **Classified** the formulae to be used in finding the volume of a cube, cuboid, and cylinder.
3. **Solve** the problem based on lateral and total surface area.
4. **Illustrate** the volume of a cube, cuboid, and cylinder.
5. **Develop** techniques and skills in calculation

Process Skills/ Teaching Method:

- Explanation (with example), Demonstration, Heuristic, and Induction method.

Learning Resources: (TLM/ Teaching Aids)

1. Model: Aiawt (Crab trap), Chingal Thlawrbel (Leaching funnel), Mizo In (Typical Mizo house), Tap (Fire place), Arbawm (Chicken basket), Tuium (Mizo water bottle), Chhemthei.
2. Chart
3. Black/Whiteboard
4. Marker/chalk

Learner's previous knowledge

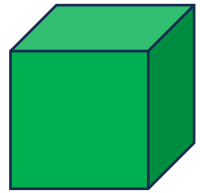
The students are familiar with the basic concepts of rectangle, square, triangle, parallelogram, and circle

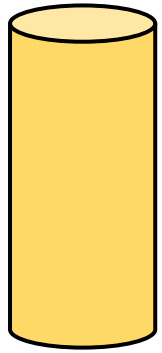
Introduction:

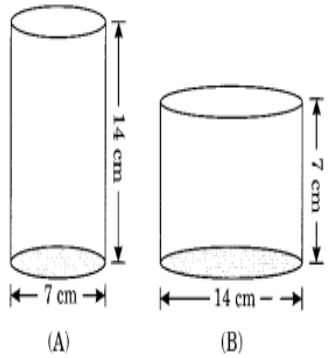
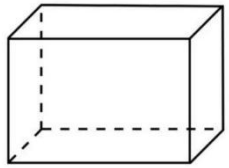
S. No.	Teacher's Activity	Student's Activity
1.	Are we all familiar with cubes and cuboids?	Yes
2.	What are the dissimilarities?	In a cube, all sides are equal whereas a cuboid does not.
3.	Name a few examples of cube or cuboidal shapes that we use and see in daily life.	Building structure, rubric cube, truck body, aquarium, parcel, etc.
4.	Do you know a cylinder?	Yes
5.	Can you please give an example of a cylinder that we use in day-to-day life?	Pencil, gas cylinder, syntax (water tank), chalk, etc

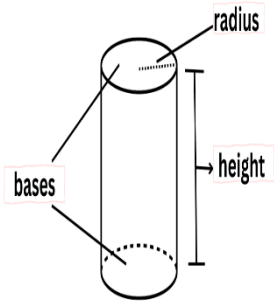
Statement of the Problem:

So, today we are going to study and discuss Some special parallelograms.

Presentation:					
S. No.	**Teaching Point**	**5E component**	**Teachers' Activity**	**Students' activity**	**Black/white board work**
1.	Cube		What is a cube? The teacher asks a student about a cube. Very good, thank you. Cubes are common and useful in real-life situations that we can see and unused in every corner of the workplace, home, etc. An example of a cube from Mizo cultural materials is Thlam (Jhum hat). As mentioned, cubes have equal length, breadth, and height. Volume of cube = a^3 where a is the side of the cube	A cube is a three-dimensional object having 6 faces, 8 vertices, and 12 edges of equal length. Students will listen very carefully.	
2.	Cuboid		The teacher tries to recall students' knowledge by asking a cuboid? Cuboids are also very useful in daily life.	Unlike a cube, cuboids have unequal sides.	

			Also, we have a few cuboidal structures in Mizo cultural materials such as Kho (square base small basket), Ipte Pui (Mizo traditional bag), typical Mizo house. Here is the formula for finding The volume of cuboid = lxbxh Where, h= height, l= length, b= breadth.	Students will pay attention to what the teacher is saying.	
3	Cylinder		The teacher asks, are we all aware of a cylinder? Can you please define a cylinder? A cylinder is nothing but a fixed-distance 3-D solid consisting of two parallel bases connected by a curving surface. A few examples of cylinders from Mizo cultural materials are as follows: Chhemthei Herhsawp (Mizo stool) Kahpuk (Bamboo toy gun) Vaibel (Smoking pipe) Tawtawrawt (Bamboo Trumpet) Formula for finding Volume of cylinder = $\pi r^2 h$	Yes no answer students will listen very carefully.	

			Where, r = radius, h = height		
4.	Numerical		Qns. The diameter of cylinder A is 7cm, and the height is 14cm. The diameter of cylinder B is 14 cm and the height is 7 cm. Without doing any calculation, can you suggest whose volume is greater? Verify it by finding the volume of both cylinders. Check whether the cylinder with great volume also has a greater surface area. Ans: the teacher asks the students; can you guess the answer? Let's check whether you are right or not Volume of A = $\pi r^2 h = \frac{22}{7} X \frac{7}{2} X \frac{7}{2} X 14 = 539 cm^3$ Volume of B = $r^2 h = \frac{22}{7} X 7 X 7 X 7 = 1078 cm^3$ Yes, you were right, the second cylinder has greater volume and surface area.	The second cylinder	
6.	Numerical		Qns. Find the height of a cuboid whose base area is 180 cm^2 and volume is 900 cm^3. Ans: Do you remember the formula for area of rectangle and volume of cuboid. We have, Area = lxb=180	lxb and lxbxh	

			Volume = 900 ⇒ lxbxh = 900 ⇒ 180 x h = 900 ⇒ h = 5cm.		
7.	Numerical		Qns. Find the height of the cylinder whose volume is 1.54m^3 and the diameter of the base is 140cm. Ans: We have, diameter = 140, radius = 70 Do you remember the volume of a cylinder Volume of cylinder = 1.54m^3 ⇒ $\pi r^2 h$ = 1.54 x100x100x100 cm^3 ⇒ 22/7x70x70xh = 154x100x100 ⇒ h = $\frac{154X100X100}{15400}$ ⇒ h = 100 cm = 1 m.	Students will give the formula.	 A cylinder
Closer Statement: So, today we have studied the volume of a cube, cuboid, and cylinder.					
Assessment: 1. Given a cylindrical tank, in which situation will you find surface area and in which situation volume a) To find how much it can hold					

b) Number of cement bags required to plaster it.

c) To find the number of smaller tanks that can be filled with water from it.

2. A cuboid is of dimensions 60cm X 54cm X 30cm. How many small cubes with sides of 6cm can be placed in the given cuboid?
3. A milk tank is in the form of a cylinder whose radius is 1.5m and length is 7m. Find the quantity of milk in liters that can be stored in the tank.

Recapitulation:

1. Meaning and calculation of the volume of a
    a) Cube
    b) Cuboid
    c) Cylinder

Home Assignment:

1. If each edge of a cube is doubled,
    a) How many times will its surface area increase?
    b) How many times will its volume increase?
2. Water is poured into a cuboidal reservoir at the rate of 60 litres per minute. If the volume of the reservoir is $108m^3$, find the number of hours it will take to fill the reservoir.

Aiawt (crab trap)

Chingal Thlawrbel (leaching funnel)

Arbawm (chicken basket)

Mizo In (typical Mizo house)

Chhemthei

Tuium (Mizo water bottle)

Ipte Pui (Mizo traditional bag),

Tap (fire place)

Lesson Plan 13

Date : _____ Class : VIII

Section : _____ Period : _____

Duration: _____ Subject: _____

Unit : Introduction to Graphs Topic : Types of Graphs

General Objectives:

To develop: -

1. Knowledge of the graphical representation of data
2. Understanding of different types of graphs
3. The use of imagination, reasoning, and observation.
4. Categorization of different types of graphs
5. Spatial ability and apply it in real life.

Learning Objectives (Specific):

After teaching the lesson, the learner will be able to:

1. **Recognise** the bar graph, pie graph, histogram, and line graph
2. **Verify** the different representations of graphs.
3. **Explain** the bar graph, pie graph, histogram, and line graph
4. **Examine** the content of the bar graph, pie graph, histogram, and line graph
5. **Draw** a figure of a bar graph, a pie graph, histogram, and a line graph

Process Skills/ Teaching Method:

- Explanation (with example), Demonstration, Heuristic, and Induction method.

Learning Resources: (TLM/ Teaching Aids)

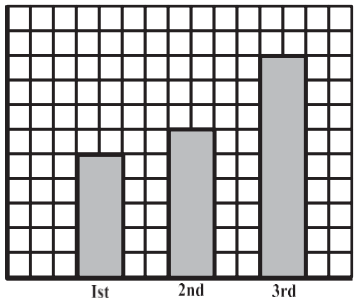
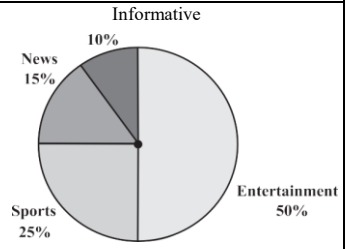
1. Model: Baibel (Earthen pot), Belval, Darngun kual (spiral brass bangles), Samkhuih (traditional comb), Ngotekherh, Sairawkherh, Pher (Bamboo mat board)
2. Chart
3. Black/Whiteboard
4. Marker/chalk

Learner's Previous Knowledge

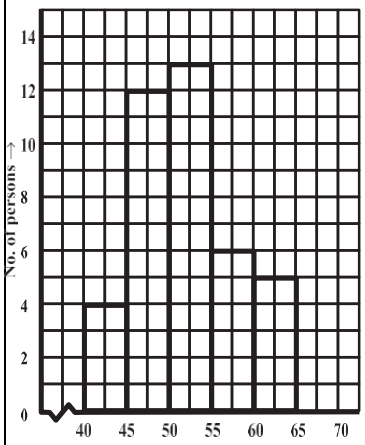
The students are familiar with the basic concepts of graphs.

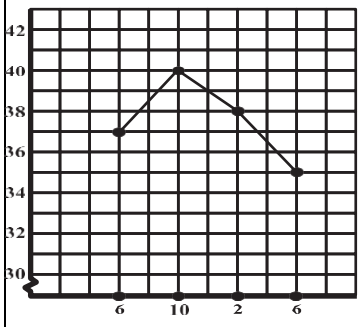
Introduction:

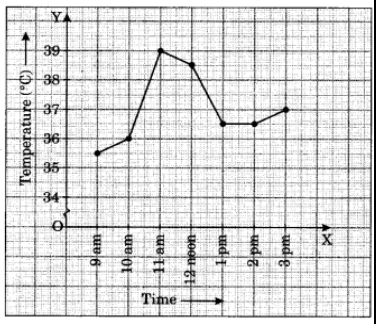
S. No.	Teacher's Activity	Student's Activity
1.	Have you seen graphs in newspapers, television, magazines, books, etc?	Yes sir
2.	What is the purpose?	To show numerical facts in numerical form so that they can be easily understood.
3.	What are graphs?	Graphs are visual representations of data collected.
4.	Can data be presented in the form of a table?	Yes, it can be represented in tabular form; however, graphical representation is easier to understand.
5.	Why is it easier to understand than a table?	This is particularly true when a trend or comparison needs to be shown.

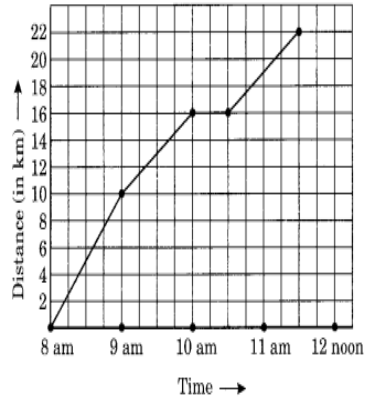
Statement of the Problem:					
So, today we are going to study and discuss types of graphs.					
Presentation:					
S. No.	**Teaching Point**	**5E component**	**Teachers' Activity**	**Students' activity**	**Black/white board work**
1.	Bar graph	Engage and Explore	Do we know what a bar graph is? The teacher explains and gives the definition that A bar graph is used to show comparisons among categories. It may consist of two or more parallel vertical (or horizontal) bars (rectangles). The bar graph in Figure shows Anu's mathematics marks in the three terminal examinations. It helps us to compare her performance easily and can clarify that she has shown good progress. The teacher gives a Pher (bamboo mat board) as an example of a graph sheet.	No response Students will listen very carefully.	
2.	Pie graph	Engage and Explore	What is a pie graph? A pie graph is used to compare parts of a whole. The circle represents the whole. A fig is a pie-graph. It shows the percentage of viewers watching different types of TV channels.	No response Students will listen very carefully.	

<table>
<tr><td></td><td></td><td></td><td>Cultural materials such as: Baibel (Earthen pot), Belval, Darngun kual (spiral brass bangles), Darkhuang (musical drum) can depict a pie graph.</td><td></td><td></td></tr>
<tr><td>3</td><td>Histogram</td><td>Engage and Explore</td><td>Are we familiar with a histogram?
The teachers give the definition and explain with the help of an example.
A Histogram is a bar graph that shows data in intervals. It has adjacent bars over the intervals.
<table><tr><td>Weight (kg)</td><td>40-45</td><td>45-50</td><td>50-55</td><td>55-60</td><td>60-65</td></tr><tr><td>No. of person</td><td>4</td><td>12</td><td>13</td><td>6</td><td>5</td></tr></table>An example of a histogram is Samkhuih (traditional Mizo comb)</td><td>No sir.

Students listen and pay attention</td><td> 
</td></tr>
<tr><td>4.</td><td>Line graph</td><td>Engage and Explore</td><td>What is a line graph?
The teacher explained that a line graph displays data that changes continuously over periods of time.

The teacher explains that Pher (bamboo mat board Ngotekherh can be used as a Graph sheet. Also, Mizo sairawkher can be used as a curve.</td><td>No response</td><td> 
</td></tr>
<tr><td>5.</td><td>Numerical</td><td></td><td>Qns: The following graph shows the temperature of a patient in a hospital, recorded every hour.</td><td></td><td></td></tr>
</table>

		Explain and Elaborate	a) What was the patient's temperature at 1 pm? b) When was the patient's temperature 38.5°C? c) The patient's temperature was the same two times during the period given. What were the two times? d) What was the temperature at 1:30 pm? How did you arrive at your answer? e) During which periods did the patient's temperature show an upward trend? Solution: a) The patient's temperature at 1 pm was 36.5°C b) The patient's temperature was 38.5°C at 12:00 noon. c) The patient's temperature was 36.5°C at 1 pm and 2 pm. d) The temperature at 1:30 pm was 36.5°C. We have taken the mid value of 1 pm. and 2 pm, i.e., 1:30 p.m and proceed perpendicularly upwards to meet the horizontal line showing 36.5°C.		

			e) During 9 am to 10 am and 10 am to 11 am, the temperature showed an upwards trend		
6.	Numerical	Explain and Elaborate	Qns: A courier-person cycle from a town to a neighbouring suburban area to deliver a parcel to the merchant. The following graph shows his distance from the town at different times. a) What is the scale taken for the time axis? b) How much time did the person take for travel? c) How far is the place of the merchant from the town? d) Did the person stop on his way? Explain? e) During which period did he ride fastest? Solution: a) Scale taken on time-axis i.e., the x-axis is 4 units = 1 hours b) Total time taken by the person for the total journey is 3 hours 30 minutes. c) The place of the merchant is at a distant of 22 km from the town.		

			d) Yes, this is indicated by the horizontal part of the graph clearly the person stopped from 10 am to 10:30 am. e) He rode fastest between 8 am and 9 am		

Closer Statement:

So, today we have learned about the types of graphs.

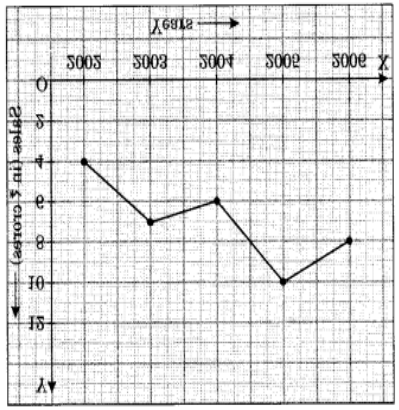
Recapitulation:

1. Bar graph
2. Pie graph
3. Histogram
4. Line graph

Assessment:

Qns1 : The following line graph shows the yearly sales figures for a manufacturing company

(a) What were the sales in (i) 2002 (ii) 2006?
(b) What were the sales in (i) 2003 (ii) 2005?
(c) Compute the difference between the sales in 2002 and 2006.
(d) In which year was there the greatest difference between the sales as compared to its previous year



Home Assignment:

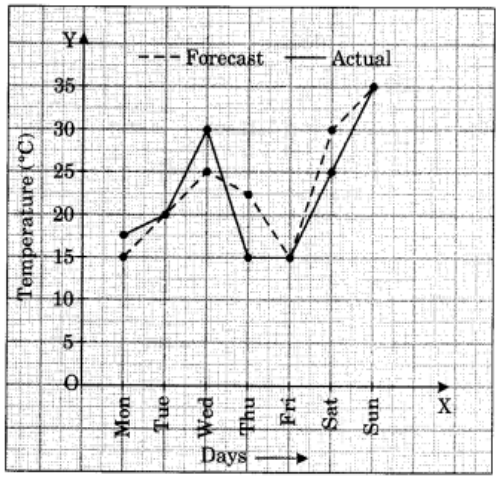
The following graph shows the temperature forecast and the actual temperature for each day of a week.

(a) On which days was the forecast temperature the same as the actual temperature?

(b) What was the maximum forecast temperature during the week?

(c) What was the minimum actual temperature during the week?

(d) On which day did the actual temperature differ the most from the forecast temperature?



Baibel (earthen pot)

Belval

Darkhuang (Smusical drum)

Samkhuih (traditional comb)

Ngotekherh

Sairawkherh

Darngun kual (spiral brass bangles)

Pher (bamboo mat board)

Lesson Plan 14

Date : _____	Class : VIII _____
Section : _____	Period : _____
Duration: _____	Subject: _____
Unit : Introduction to Graphs _____	Topic : Linear graphs and its application. _____

General Objectives:

To develop: -

1. Knowledge of the graphical representation of data
2. Understanding of different types of graphs
3. The use of imagination, reasoning, and observation.
4. Categorization of different types of graphs
5. Spatial ability and apply it in real life.

Learning Objectives (Specific):

After teaching the lesson, the learner will be able to:

1. **Recognise** the linear graphs and their application.
2. **Explain** linear graphs and their application.
3. **Solve** problems based on linear graphs.
4. **Examine** the content of linear graphs.
5. **Draw** a figure of linear graphs.

Process Skills/ Teaching Method:

- Explanation (with example), Demonstration, Heuristic, and Induction method.

Learning Resources: (TLM/ Teaching Aids)

1. Model: Ngotekherh, Sairawkherh, Pher (Bamboo mat board), Chhihri (sieve)
2. Chart
3. Black/Whiteboard
4. Marker/chalk

Learner's Previous Knowledge

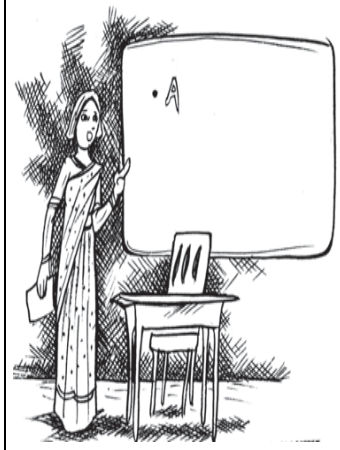
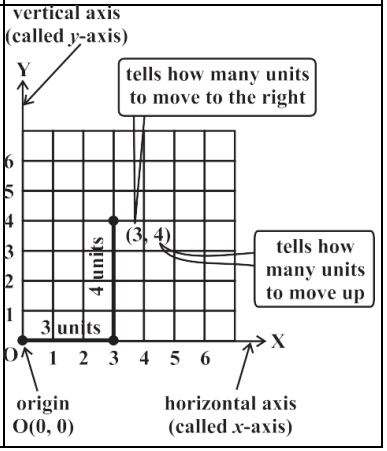
The students are familiar with the basic concepts of bar graphs, pie graphs, histograms, and line graphs.

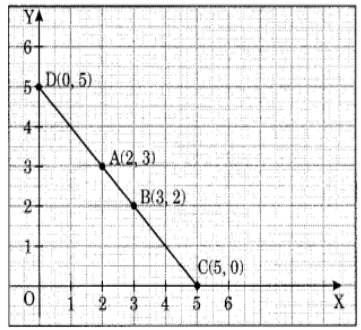
Introduction:

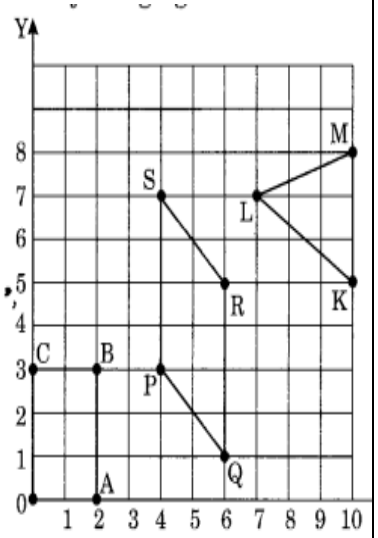
S. No.	Teacher's Activity	Student's Activity
1.	Are we familiar with a graph?	Yes
2.	Can you please give the definition?	A graph is a visual way to represent numerical data, making it easier to understand and analyze than raw numbers
3.	Do you think it is important in real life?	yes
4.	Please give examples?	Calculating the cost of a service, understanding distance-time relationships, or converting units of measurement.
5.	How many types of graphs do you know?	Bar graph, Pie graph, Histogram, and Line graph

Statement of the Problem:

So, today we are going to study and discuss linear graphs and their applications

Presentation:					
S. No.	**Teaching Point**	**5E component**	**Teachers' Activity**	**Students' activity**	**Black/white board work**
1.	Linear graph	Engage and Explore	What is a linear graph? The teacher explains that a line graph consists of bits of line segments joined consecutively. Sometimes the graph may be a whole unbroken line. Such a graph is called a **linear graph**. To draw such a line, we need to locate some points on the graph sheet. We will now learn how to locate points conveniently on a graph sheet. An example of a graph sheet can be Pher (Bamboo mat board) and Ngotekherh.	No response Students listen very carefully.	
2	Coordinates	Engage and Explore	Qns: Are you familiar with Co-ordinate? The teacher explains to the students that, suppose you go to an auditorium and search for your reserved seat. You need to know two numbers, the row number and the seat number. This is the basic method for fixing a point in a plane. Observe in the given Figure how the point (3, 4), which is 3 units from the left edge and 4 units	Students confuse They listen to the teacher very carefully	

			from the bottom edge, is plotted on a graph sheet. The graph sheet itself is a square grid. We draw the x and y axes conveniently and then fix the required point. 3 is called the x-coordinate of the point; 4 is the y-coordinate of the point. We say that the coordinates of the point are (3, 4). An example of a graph sheet from cultural materials is Chhihri (Sieve).		
3.	Numerical	Explain and Elaborate	Qns1: Draw the line passing through (2, 3) and (3, 2). Find the coordinates of the points at which this line meets the x-axis and y-axis. Ans: CD is the required line passing through the points A (2, 3), B (3, 2), which meets the x-axis at C (5, 0) and y-axis at D (0, 5).	Students try to understand the solution.	
4.	Numerical	Explain and Evaluate	Qns 2: State whether True or False. Correct, that is false. (i) A point whose x-coordinate is zero and y-coordinate is non-zero will lie on the y-axis. (ii) A point whose y-coordinate is zero and x-coordinate is 5 will lie on the y-axis.		

			(iii) The coordinates of the origin are (0, 0). Solution: (i) True (ii) False, the point will lie on the x-axis with coordinates (5, 0). (iii) True		
5.	Numerical	Explain and Elaborate	Qns 3: Write the coordinates of the vertices of each of these adjoining figures. Ans: Required coordinates are as follows: Coordinates of rectangle OABC are: O(0, 0), A(2, 0), B(2, 3), C(0, 3) Coordinates of parallelogram PQRS are: P(4, 3), Q(6, 1), R(6, 5), S(4, 7) Coordinates of triangle KLM are: K(10, 5), L(7, 7), M (10, 8).	Students try to understand the solution.	
5.	Numerical	Explain and Elaborate	Qns 4: Draw the graph for the following:		

(*i*)

Side of square (in cm)	2	3	3.5	5	6
Perimeter (in cm)	8	12	14	20	24

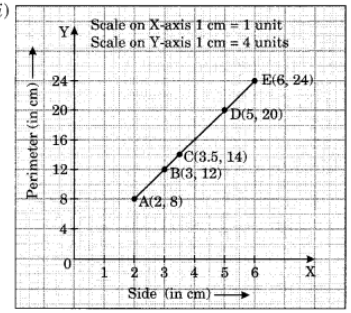
Is it a linear graph?

(*ii*)

Side of square (in cm)	2	3	4	5	6
Area (is cm^2)	4	9	16	25	36

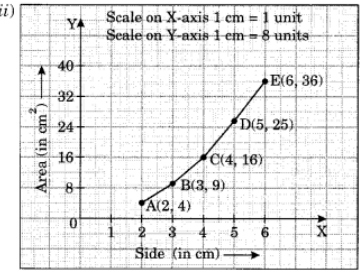
Students try to understand the solution.

(*i*)



Yes, it is a linear graph.

(*ii*)



No, it is not a linear graph.

Closer Statement:

So, today we have learned about the linear graphs and application

Recapitulation:

Meaning, understand, and draw

1. Linear graph
2. Coordinates

Assessment:

1. Plot the following points on a graph sheet. Verify if they lie on a line.
   (a) A (4,0), B(4,2), C(4,6), D(4,2.5)
   (b) P(1,1), Q(2,2), R(3,3), S(4,4)
   (c) K(2,3), L(6,3), M(5,5), N (2,5)

Home Assignment:

1. Draw the graphs for the following tables of values, with suitable scales on the axes.
   (a) Cost of apples

Number of apples	1	2	3	4	5
Cost (in ₹)	5	10	15	20	25

   (b) Distance travelled by car.

Time (is hours)	6 am	7 am	8 am	9 am
Distance (is km)	40	80	120	160

Chhihri (Sieve)

Pher (bamboo mat board)

Ngotekherh

Sairawkherh

ACHIEVEMENT TEST

Name: ..... Class: .....

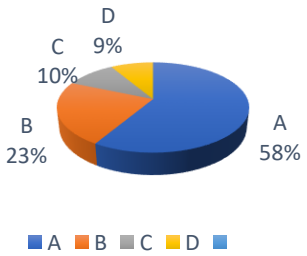
School: ..... Roll No: .....

Male: ☐ Female: ☐

General Instructions:

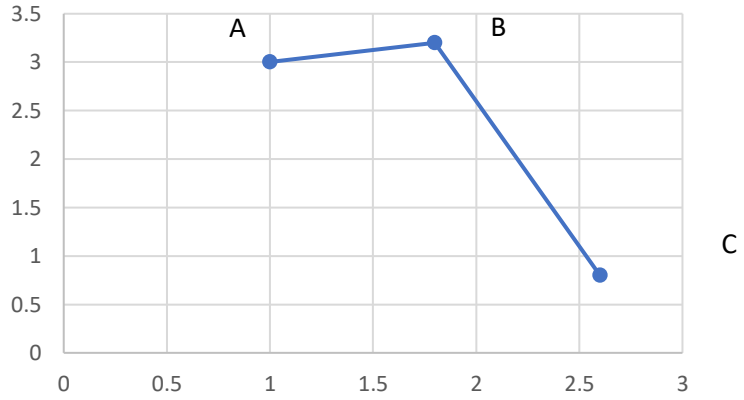
- ☞ Stay calm.
- ☞ Listen carefully to the directions of your teacher.
- ☞ Read each question and answer the questions carefully.
- ☞ Attempt all questions.
- ☞ All questions carry equal marks.

1. Among the following, which one is not a quadrilateral?
   a) Square b) Rectangle
   c) Triangle d) Parallelogram
2. In a rectangle, the diagonals are 2x + 1 and 3x – 1, respectively. Value of 'x' is
   a) 4 b) 3
   c) 2 d) 1
3. A rhombus's sides are each 7cm long. Determine its perimeter.
   a) 28 b) 27
   c) 26 d) 25
4. The average score of a group is



   a) 20 b) 25
   c) 30 d) 35
5. Area of Rhombus having diagonals d_1 and d_2 is
   a) $\frac{1}{2}d_1d_2$ b) $\frac{1}{4}d_1d_2$
   c) d_1d_2 d) None of the above

6. **The co-ordinate of a point A is**



a) (0.5,3) b) (1, 2.5)

c) (1.5,3) d) (1,3)

7. **If a cuboidal box has length, breadth, and height, of 10 cm, 20 cm, and 30 cm respectively. Then its volume (capacity) is:**
   a) 6000 cm^3 b) 6500 cm^3
   c) 3600 cm^3 d) 4800 cm^3

8. If a triangle has two angles of 70° and 60°, respectively. Calculate the third angle's measurement.
   a) 50 b) 60
   c) 40 d) 70

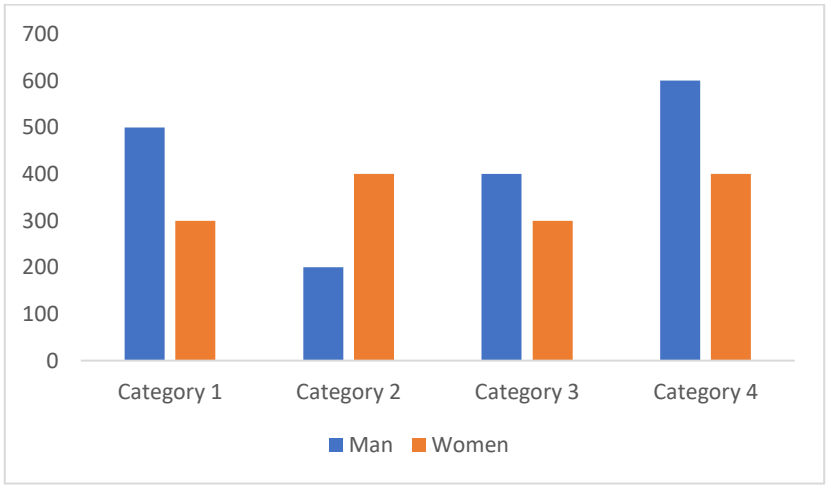
9. Which of these quadrilaterals is a regular one?
   a) Rectangle b) Kite
   c) Trapezium d) Square

10. Circumference of a circle with radius 'r' is
    a) $2\pi r$ b) $3\pi r$
    c) $2\pi r^2$ d) πr^2

11. **If a coin is tossed once, what is the probability of getting a tail?**
    a) **2** **b)1**
    c) **½** **d) 0**

12. **How many edges does a cuboid have?**
    a) **6** **b) 8**
    c) **10** **d) 12**

13. From the given chart, the total number of men and women is



a) 1700, 1400 b) 1600, 1500

c) 1800, 1400 d) 1400, 1700

14. A polygon having a minimum number of sides is

a) Rectangle b) square

c) Triangle d) hexagon

15. **Bird eye view (top view) of a cube looks like**

a) **Square** **b) Rectangle**

c) **Triangle** **d) circle**

16. The point (5,0) belongs on which of the following?

a) y-axis b) origin

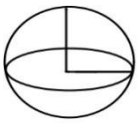
c) x-axis d) None of the above

17. The volume (Capacity) of a Cylinder is with radius 'r' and height 'h' is

a) πr^2h b) $2\pi r^2$h

c) $\frac{1}{2}\pi r^2$h d) πrh

18. **How many faces does a sphere have?**



a) **1** **b) 2**

c) **3** **d) None**

19. The area of the square with a side of length 's' is:

a) 2s b) 4s

c) $\frac{a}{2}$ d) s^2

20. An example of a cylindrical shape is:

a) Pipes
b) Cold drink cans
c) Motor steering
d) All of the above

21. A kite has diagonals that:

a) bisect each other
b) are perpendicular to each other
c) do not bisect each other
d) none of the following

22. The Co-ordinate (0,0) lies at:

a) origin
b) y-axis
c) x-axis
d) None of the above

23. With given two diagonals, we can construct a:

a) Parallelogram
b) Kite
c) Rhombus
d) Rectangle

24. **Which of the following is a 3-D shape**

a) **Square**
b) Rectangle
c) **Cube**
d) Triangle

25. For constructing a square, we need to know:

a) Only one side length
b) All the interior angles
c) All the side lengths
d) Only one interior angle

26. How many sets of data are displayed by a double graph?

a) One
b) Two
c) Three
d) Four

27. How many circles does a hemisphere have?

a) 1
b)2
c) 3
d) 4

28. If two cubes of sides 2cm are joining together, the resulting volume of a new object is

a) 8 cm^3
b) 16 cm^3
c) 12 cm^3
d) 20 cm^3

29. A cylindrical bucket having a radius and height of 7cm can contain how many litres of water?

a) 1028 cm^3
b) 1038 cm^3
c) 1058 cm^3
d) 1078 cm^3

30. How many small cubes can be made from a cube of sides 9cm?

a) 9 cubes
b) 16 cubes
c) 27 cubes
d) 24 cubes

Answer key

Qns No.	Option	Answer
1.	c	Triangle
2.	c	2
3.	a	28
4.	b	25
5.	a	$\frac{1}{2}d_1d_2$
6.	d	(1,3)
7.	a	6000 cm^3
8.	a	50^0
9.	d	Square
10.	a	$2\pi r$
11.	c	1/2
12.	d	12
13.	a	1700, 1400
14.	c	Triangle
15.	a	Square
16.	c	x-axis
17.	a	πr^2h
18.	d	none
19.	d	s^2
20.	d	All of the above
21.	b	Are perpendicular to each other
22.	a	Origin
23.	c	Rhombus
24.	c	Cube
25.	a	Only one side length
26.	b	Two
27.	a	1
28.	b	16 cm^2
29.	d	1078 cm^2
30.	c	27 cubes

Semi-Structured Interviewed Schedule

Name:- _____ **Class :-**_____

School :- _____ **Section :-** _____

General instructions: -

- **Stay calm**
- **Listen carefully to the directions of your teacher**
- **Read each question and answer the questions carefully**

1. How do you like learning mathematics in school?
   ……
   ……
   ……
2. Which activity do you like most while learning mathematics?
   ……
   ……
   ……
3. Is the way of explaining the contents of the chapters similar to your regular Stay Calm textbook or different from your regular textbook? If yes, then in what ways?
   ……
   ……
   ……..
4. Which component do you find most familiar and relevant to your daily life?
   ……
   ……
   ……

5. Do the materials we have shown you in the classroom, have you ever seen them earlier if yes, where?

……

……

……

6. Does each unit chapter contain special tricks and hints for elaborating the concepts?

……

……

……

7. Which concept/ chapter/topic was mostly related to your daily life?

……

……

……

8. Would you like to study another subject with the help of a similar technique?

……

……

……

9. Which components and techniques of discussing mathematics have you liked the most? Tell their names (specifically).

……

……

……

10. Have you enjoyed learning mathematics, especially visualizing solid shapes and measurement with the help of this interactive technique?

……

……

……

Any other remarks

……

……

……

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P. N. Mehrotra *(Moradabad)*

ANSWER SHEET

of

MGTI-M

(Hindi/English Version)

कृपया निम्न सूचनाएँ भरिये दिनांक ***(Date)*** ☐☐☐☐☐☐☐☐

(Please fill up the following informations) :

नाम **(Name)**_____

आयु **(Age)**_____

लिंग **(Sex)** : पुरुष **(Male)** ☐ स्त्री **(Female)** ☐

कक्षा **(Class)**_____

विद्यालय **(School)**_____

क्षेत्र **(Area)** : ग्रामीण **(Urban)** ☐ शहरी **(Rural)** ☐

धर्म **(Religion)**_____ जाति **(Caste)**_____

पिता का व्यवसाय **(Father's Occupation)**_____

मासिक आय **(Monthly Income)**_____

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• Check

भाग-1 शाब्दिक परीक्षण (Part-1 : Verbal Test)												भाग-2 अशाब्दिक परीक्षण (Part-2 : Non-Verbal Test)											
Q. No.	ANSWER					Q. No.	ANSWER					Q. No.	ANSWER					Q. No.	ANSWER				
	1	2	3	4	5		1	2	3	4	5		1	2	3	4	5		1	2	3	4	5
1.	☐	☐	☐	☐	☐	26.	☐	☐	☐	☐	☐	1.	☐	☐	☐	☐	☐	26.	☐	☐	☐	☐	☐
2.	☐	☐	☐	☐	☐	27.	☐	☐	☐	☐	☐	2.	☐	☐	☐	☐	☐	27.	☐	☐	☐	☐	☐
3.	☐	☐	☐	☐	☐	28.	☐	☐	☐	☐	☐	3.	☐	☐	☐	☐	☐	28.	☐	☐	☐	☐	☐
4.	☐	☐	☐	☐	☐	29.	☐	☐	☐	☐	☐	4.	☐	☐	☐	☐	☐	29.	☐	☐	☐	☐	☐
5.	☐	☐	☐	☐	☐	30.	☐	☐	☐	☐	☐	5.	☐	☐	☐	☐	☐	30.	☐	☐	☐	☐	☐
6.	☐	☐	☐	☐	☐	31.	☐	☐	☐	☐	☐	6.	☐	☐	☐	☐	☐	31.	☐	☐	☐	☐	☐
7.	☐	☐	☐	☐	☐	32.	☐	☐	☐	☐	☐	7.	☐	☐	☐	☐	☐	32.	☐	☐	☐	☐	☐
8.	☐	☐	☐	☐	☐	33.	☐	☐	☐	☐	☐	8.	☐	☐	☐	☐	☐	33.	☐	☐	☐	☐	☐
9.	☐	☐	☐	☐	☐	34.	☐	☐	☐	☐	☐	9.	☐	☐	☐	☐	☐	34.	☐	☐	☐	☐	☐
10.	☐	☐	☐	☐	☐	35.	☐	☐	☐	☐	☐	10.	☐	☐	☐	☐	☐	35.	☐	☐	☐	☐	☐
11.	☐	☐	☐	☐	☐	36.	☐	☐	☐	☐	☐	11.	☐	☐	☐	☐	☐	36.	☐	☐	☐	☐	☐
12.	☐	☐	☐	☐	☐	37.	☐	☐	☐	☐	☐	12.	☐	☐	☐	☐	☐	37.	☐	☐	☐	☐	☐
13.	☐	☐	☐	☐	☐	38.	☐	☐	☐	☐	☐	13.	☐	☐	☐	☐	☐	38.	☐	☐	☐	☐	☐
14.	☐	☐	☐	☐	☐	39.	☐	☐	☐	☐	☐	14.	☐	☐	☐	☐	☐	39.	☐	☐	☐	☐	☐
15.	☐	☐	☐	☐	☐	40.	☐	☐	☐	☐	☐	15.	☐	☐	☐	☐	☐	40.	☐	☐	☐	☐	☐
16.	☐	☐	☐	☐	☐	41.	☐	☐	☐	☐	☐	16.	☐	☐	☐	☐	☐	41.	☐	☐	☐	☐	☐
17.	☐	☐	☐	☐	☐	42.	☐	☐	☐	☐	☐	17.	☐	☐	☐	☐	☐	42.	☐	☐	☐	☐	☐
18.	☐	☐	☐	☐	☐	43.	☐	☐	☐	☐	☐	18.	☐	☐	☐	☐	☐	43.	☐	☐	☐	☐	☐
19.	☐	☐	☐	☐	☐	44.	☐	☐	☐	☐	☐	19.	☐	☐	☐	☐	☐	44.	☐	☐	☐	☐	☐
20.	☐	☐	☐	☐	☐	45.	☐	☐	☐	☐	☐	20.	☐	☐	☐	☐	☐	45.	☐	☐	☐	☐	☐
21.	☐	☐	☐	☐	☐	46.	☐	☐	☐	☐	☐	21.	☐	☐	☐	☐	☐	46.	☐	☐	☐	☐	☐
22.	☐	☐	☐	☐	☐	47.	☐	☐	☐	☐	☐	22.	☐	☐	☐	☐	☐	47.	☐	☐	☐	☐	☐
23.	☐	☐	☐	☐	☐	48.	☐	☐	☐	☐	☐	23.	☐	☐	☐	☐	☐	48.	☐	☐	☐	☐	☐
24.	☐	☐	☐	☐	☐	49.	☐	☐	☐	☐	☐	24.	☐	☐	☐	☐	☐	49.	☐	☐	☐	☐	☐
25.	☐	☐	☐	☐	☐	50.	☐	☐	☐	☐	☐	25.	☐	☐	☐	☐	☐	50.	☐	☐	☐	☐	☐

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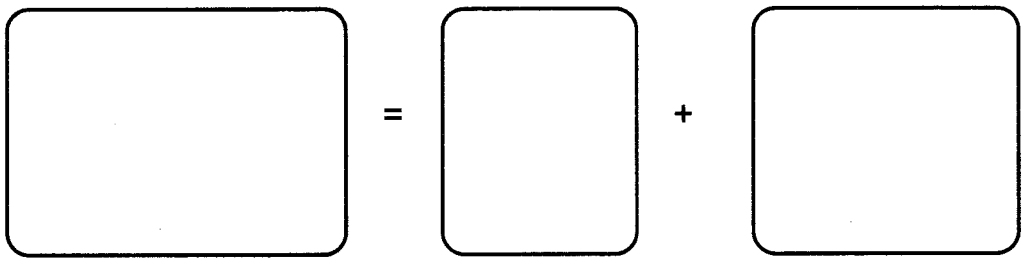
PART (भाग) 1 : VERBAL TEST (शाब्दिक परीक्षण)

Sr. No.	Sub Test	Item Sr. No.	Total	Score
1.	Analogy [A]	7, 12, 17, 28, 31, 33, 36, 38, 41, 46	10	
2.	Number Series [N]	22, 25, 29, 35, 37, 39, 42, 44, 48, 50	10	
3.	Classification [C]	1, 3, 6, 8, 10, 13, 15, 18 20, 43	10	
4.	Vocabulary [V]	4, 16, 19, 21, 24, 27, 30, 32, 34, 49	10	
5.	Reasoning [R]	2, 5, 9, 11, 14, 23, 26, 40, 45, 47	10	
		Total	50	

PART (भाग) 2 : NON-VERBAL TEST (अशाब्दिक परीक्षण)

Sr. No.	Sub Test	Item Sr. No.	Total	Score
1.	Analogy [L]	3. 5. 7, 23, 27, 42, 44, 46, 48, 50.	10	
2.	Arrangement [G]	4, 12, 20, 28, 30, 36, 39 43, 47, 49.	10	
3.	Classification [F]	1, 10, 13, 16, 19, 26, 31, 33, 41, 45.	10	
4.	Digit Symbols [D]	2, 6, 8, 11, 14, 18, 22, 25, 35, 38.	10	
5.	Part Fitting [P]	9, 15, 17, 21, 24, 29, 32, 34, 37, 40	10	
		Total	50	

Total Obtained Score = Verbal + Non-Verbal



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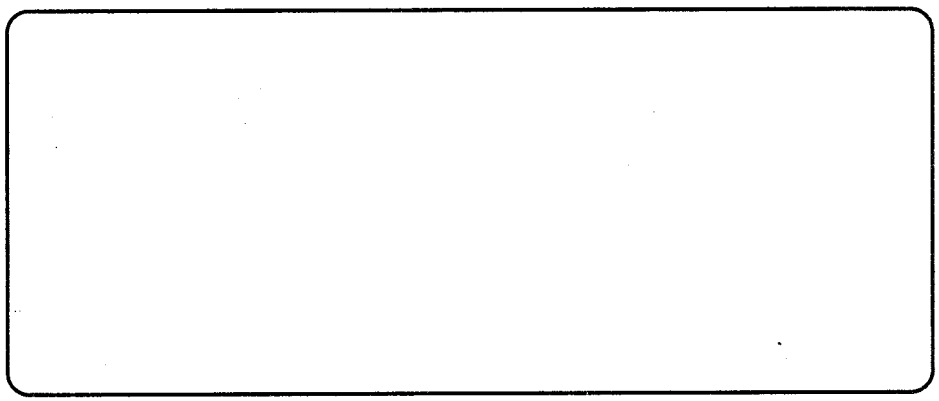

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IZAWL
May 22, 2024

May 08, 2024, 12:31

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BRIEF BIO-DATA OF THE CANDIDATE

NAME	:	TBC LALRAMNGHAKA
FATHER'S NAME	:	TBC TLANGHMINGTHANGA
D.O.B	:	26.04.1994
ADDRESS	:	ZOTLANG, CHAMPHAI MIZORAM, 796321
GENDER	:	MALE
RELIGION	:	CHRISTIAN
MARITAL STATUS	:	UNMARRIED
EDUCATIONAL QUALIFICATION	:	MSc (Mathematics), B.Ed., M.Ed.
PH.D. REGISTRATION NO. & DATE	:	MZU/Ph.D./2113 of 06.09.2022
DEPARTMENT	:	EDUCATION
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Ethnomathematical Pedagogy for Peacebuilding: A Holistic Approach to Education

Tbc Lalramnghaka[1], Dr. Prateek Chaurasia[2], Prof. Lokanath Mishra[3]

[1]Research Scholar, Department of Education, Mizoram University
[2]Co-Supervisor, Faculty of Education, Banaras Hindu University,
[3]Supervisor, Department of Education, Mizoram University

Abstract
Ethnomathematics examines the relationship between culture and mathematical knowledge, highlighting the diverse ways different societies perceive and apply mathematical concepts. This method challenges the idea that mathematics is universal and culture-free by including mathematical techniques from many cultures, creating inclusivity, cultural awareness, and identity. Ethnomathematics in peace education improves empathy, intercultural understanding, and conflict resolution, preparing students to handle social and cultural differences. Culturally responsive education, collaborative learning, critical analysis, and project-based learning help students apply maths to real-world situations and encourage collaboration. Ethnomathematical pedagogy encourages social unity, critical thinking, and ethical reasoning in schools by recognising indigenous and marginalised cultures' mathematical skills. This approach promotes fairness, peace, and holistic development through education.

Keywords: Ethnomathematics, Pedagogy, Peacebuilding, Peace education

INTRODUCTION

Ethnomathematical pedagogy integrates cultural mathematical practices into education, encouraging inclusivity, contextual learning, and appreciation for cultural diversity (D'Ambrosio, 2001). In contrast to traditional mathematics, which typically portrays knowledge as universal and culture-free, ethnomathematics emphasises various ways through which societies understand, formulate, and utilise mathematical concepts (Barton, 1996). It examines the application of mathematical reasoning by individuals from diverse cultural backgrounds in crafts, architecture, commerce, agriculture, and everyday problem-solving. This methodology integrates traditional knowledge with academic mathematics, highlighting mathematics as a dynamic activity grounded in cultural experience rather than as an abstract or culture-free discipline. Ethnomathematics, a concept developed by Ubiratan D'Ambrosio, was created as a response to the dominance of Eurocentric viewpoints in mathematical education. D'Ambrosio (1990) stated that each culture has different mathematical systems designed to meet its social and environmental needs. By incorporating these systems into classroom instruction, educators promote epistemic justice and recognise the intellectual contributions of marginalised communities (Gerdes, 1994). This acknowledgement enhances students' sense of belonging and identity, especially for those who may feel excluded by traditional curricula that neglect their cultural histories. Therefore, ethnomathematical teaching not only improves mathematical understanding but also serves as a tool for empowerment and inclusion.Ethnomathematics holds significance not only for cognitive development but also for broader

societal goals, including peacebuilding, intercultural understanding, and social cohesion. Rosa and Orey (2016) describes ethnomathematics as a "pedagogy of respect," fostering intercultural dialogue through the shared language of mathematics. In multicultural communities, where social differences often arise from cultural misunderstandings, ethnomathematical approaches can encourage mutual respect by demonstrating that all cultures contribute meaningful mathematical insights. This mutual recognition of diverse knowledge systems promotes positive interactions and fosters empathy, collaboration, and tolerance among learners. Education has historically been recognised as a key element in peacebuilding. According to Galtung (1996), peace encompasses not only the absence of physical violence but also the elimination of structural and cultural inequalities. In this context, mathematics education can play a transformative role when aligned with principles of justice, inclusivity, and respect. Ethnomathematical teaching supports this aim by integrating culture, critical analysis, and problem-solving into mathematical instruction (Gavarrete, 2015). It provides students with opportunities to understand the development of mathematical ideas through social interaction and human creativity, encouraging both intellectual and ethical growth. Also, ethnomathematics enables students to critically examine which mathematical paradigms dominate educational settings and how diverse perspectives can contribute to sustainable and equitable development (Borba, 2021). This broader understanding fosters civic responsibility and empowers students to address complex social issues through collaboration rather than conflict. Ethnomathematical pedagogy enriches education by incorporating cultural diversity and connecting mathematics to real-world contexts, thus promoting a comprehensive and humanistic approach. It moves beyond rote memorisation to nurture empathy, intercultural dialogue, and ethical reasoning—skills essential for building peaceful, inclusive societies. Overall, ethnomathematical pedagogy offers an effective teaching approach that merges mathematics with culture, identity, and peace. It helps learners see themselves as active participants in knowledge creation, fostering mathematical literacy, cultural awareness, and social harmony. When the mathematical wisdom embedded in different cultures is valued, education becomes a bridge to lasting peace, justice, and universal understanding.

Theoretical Foundations of Ethnomathematics and Peace Education

Ethnomathematics and peace education are interrelated disciplines that focus on cultural significance, social equity, and conflict resolution within the educational framework. Ethnomathematics, as stated by D'Ambrosio (1985), examines mathematical methods embedded in various cultural traditions, challenging the Eurocentric perspective of mathematics as a universal, culture-free discipline. It enhances inclusivity by acknowledging the mathematical contributions of indigenous and marginalised populations, thereby cultivating a feeling of identity, dignity, and respect for diversity (Rosa & Orey, 2016). This acknowledgement is essential in educational environments because specific cultural narratives are frequently favoured, while others are reduced or neglected. Ethnomathematics turns education into a tool for establishing indigenous knowledge systems and allowing communities to recover their intellectual legacy. Peace education seeks to cultivate ideals of nonviolence, empathy, human rights, and social unity. Reardon (1988) describes it as an educational methodology that provides learners with the knowledge, skills, and attitudes essential for constructively resolving conflicts and encouraging social transformation. Integrating ethnomathematics with peace education enhances its contextual relevance and cultural awareness. Understanding and utilising multiple mathematical knowledge systems enables learners to cultivate a profound understanding of cultural heterogeneity and global interdependence (Gerdes, 2001). This method fosters international discussion and reciprocal understanding—the foundations of

harmonious cohabitation. Integrating ethnomathematics into peace education courses promotes critical thinking, empathy, and awareness of the power dynamics influencing knowledge creation. It challenges significant systems that favour Western knowledge frameworks and promotes a comprehensive understanding of mathematics as a human activity shaped by social and cultural settings. This integration develops mathematical literacy and conforms with global educational frameworks, including UNESCO's Sustainable Development Goal 4, which promotes inclusive, equitable, and quality education as a basis for lasting peace.

Cultural Relativity in Mathematics

Cultural relativity in mathematics challenges the assumption that mathematical knowledge is entirely universal and independent of human experience. However, it focuses on the complex interrelations between mathematical comprehension and the cultural, historical, and social contexts in which it is cultivated (D'Ambrosio, 2001). Mathematics is not a singular global language; rather, it is a mosaic of activities that embody humanity's numerous meanings and interactions with the world. Every community cultivates mathematical systems influenced by its distinct surroundings, economic pursuits, belief frameworks, and requirements for problem-solving (Barton, 1996). Indigenous navigational systems, African fractal construction, and Polynesian methods of estimating distance and time exemplify mathematical sophistication intimately embedded in local epistemologies (Gerdes, 1994). Ethnomathematics thereby recognises and honours many mathematical systems, challenging the supremacy of Eurocentric narratives that have traditionally portrayed Western mathematics as the sole valid manifestation of rational thought (Rosa & Orey, 2016). Numerous traditional curricula promote mathematics as objective, free of values, and independent of culture, frequently sidelining or omitting the mathematical contributions of non-Western societies (Borba, 2021). This exclusion reinforces epistemic injustice and marginalises learners whose cultural experiences are unrepresented in their schooling. Introducing ethnomathematics into the classroom promotes inclusion, enabling students to perceive mathematics as important to their lives and communities. This contextual learning enhances comprehension, elevates motivation, and cultivates cultural pride (Gavarrete, 2015). Understanding cultural relativity in mathematics has significant consequences for mutual understanding. It develops equity and mutual respect by recognising that all cultures encompass significant knowledge systems. When students engage with other mathematical traditions, they come to recognise difference not as a cause for separation but as a basis for discourse and collaboration. The recognition helps in deconstructing hierarchical knowledge frameworks that favour some perspectives while neglecting others. A comprehensive ethnomathematical pedagogy serves as a means for decolonisation, challenging epistemic supremacy and advancing social justice (D'Ambrosio & Rosa, 2017).

Embracing cultural relativity transforms mathematics education into a platform for intercultural discussion and peacebuilding. Students are taught to interrogate preconceptions, value diverse perspectives, and participate in collaborative problem-solving across cultural boundaries. These encounters foster empathy, tolerance, and critical awareness—skills vital for enduring peace in a progressively diverse society. Cultural relativity in mathematics ultimately underscores the notion that peace commences with knowledge: acknowledgement of our collective humanity manifested via the varied methods we employ to reason, quantify, and understand the world.

Peace Education and Its Integration with Ethnomathematics

Peace education aims to encourage ideals of nonviolence, social justice, and intercultural understanding, providing learners with the cognitive and emotional skills essential for conflict resolution and harmonious coexistence (Harris & Morrison, 2012). It emphasises empathy, conversation, and respect for diverse perspectives, establishing a transformative framework for addressing systemic inequality and promoting inclusive societies (Reardon, 1999). Peace education fundamentally aims to prevent violence while establishing the underpinnings of constructive peace—conditions of justice, equity, and mutual respect that uphold human dignity. Understanding that education is inherently influenced by culture, the combination of peace education with ethnomathematics promotes a comprehensive learning perspective that encourages intellectual development and ethical consciousness. Ethnomathematics, by recognising varied mathematical traditions, inherently corresponds with the objectives of peace education. It appreciates many philosophical perspectives and contests the supremacy of hegemonic discourses that depict Western mathematics as the exclusive benchmark of reason (D'Ambrosio, 2001). Ethnomathematical pedagogy enables learners to investigate mathematical concepts inherent in local art, architecture, weaving, or measurement systems, fostering an appreciation for cultural creativity and creative thinking (Barton, 1996). Such interactions cultivate intercultural comprehension, respect, and equity—fundamental principles of peace education. Integrating ethnomathematics into peace education curricula transforms mathematics classrooms into environments for dialogue, collaboration, and the deconstruction of cultural biases (Rosa & Orey, 2016). Students are urged to view mathematics not just as abstract calculation but as a collective human pursuit that unites communities across temporal and spatial dimensions. This methodology empowers marginalised communities by affirming their epistemologies and fostering self-esteem and cultural pride. It also pushes learners to critically examine issues of power, identity, and representation in knowledge production, connecting mathematics with broader social realities. Also, ethnomathematical peace education corresponds to the United Nations' Sustainable Development Goal 4, which promotes inclusive and equitable quality education as a means to achieve peace and prosperity. When mathematics education integrates cultural variety, it develops learners' abilities in empathy, ethical reasoning, and collaboration—crucial skills for global citizenship and sustainable peace. In this regard, the integration of ethnomathematics and peace education converts conventional classrooms into communities of inquiry where mathematical learning and peacebuilding coexist dynamically.

Pedagogical Approaches to Ethnomathematics for Peacebuilding

Ethnomathematical pedagogy integrates cultural knowledge into mathematics teaching, emphasising inclusivity, equity, and social justice (D'Ambrosio, 2001). In peacebuilding, pedagogical methods in ethnomathematics prioritise collaborative learning, critical pedagogy, and culturally sensitive teaching to promote conversation, mutual respect, and conflict resolution competencies (Rosa & Orey, 2016). These methodologies enable students to perceive mathematics as a humanistic and culturally integrated discipline rather than an abstract, impartial entity (Barton, 1996). Culturally responsive teaching is an effective pedagogical technique that recognises students' backgrounds and includes local mathematical practices into the curriculum (Gay, 2010). By understanding indigenous mathematical knowledge—such as traditional measurement systems, geometric patterns in art, and arithmetic in commerce—educators promote significant learning experiences that connect formal education with students' daily realities (Gerdes, 1994). This approach cultivates cultural appreciation and strengthens pupils' sense of identity,

promoting peacebuilding by encouraging respect for many traditions. A significant method is critical ethnomathematics, which challenges students to analyse power dynamics within mathematical knowledge and challenge prevailing narratives (Skovsmose, 2005). This method develops critical consciousness and social activism by including learners in debates regarding the historical application of mathematics in colonisation, economic disparities, and resistance movements (Gutiérrez, 2013). Students cultivate problem-solving abilities that transcend the classroom, utilising mathematics to address real-world challenges associated with justice and peace.

Collaborative learning is essential in ethnomathematical pedagogy for reconciliation. Collaborative group activities, peer dialogues, and community-oriented projects enable students to collaborate across cultural and social disparities (Freire, 1970). This methodology strengthens the ideals of collaboration, empathy, and intercultural comprehension—fundamental tenets of peace education (Harris & Morrison, 2012).

Finally, project-based learning (PBL) provides an effective method for integrating ethnomathematics with peacebuilding. Students may investigate mathematical topics via practical projects, such as creating sustainable homes utilising indigenous geometric principles or analysing economic disparities through statistical analysis (D'Ambrosio & Rosa, 2017). These initiatives enhance the engagement and relevance of mathematics while cultivating problem-solving abilities crucial for peacebuilding. By implementing these instructional strategies, educators may transform mathematics education into an effective instrument for promoting social unity, critical thinking, and enduring peace.

Conclusion

Ethnomathematical pedagogy promotes a revolutionary methodology for promoting peace by combining cultural knowledge, mathematical comprehension, and social unity within educational frameworks. This comprehensive approach acknowledges that mathematical knowledge is not culturally impartial but is deeply embedded in human activities, beliefs, and perspectives (D'Ambrosio, 2001). These mathematical concepts within cultural contexts enhance students' cognitive and emotional comprehension, cultivating an awareness of various viewpoints and encouraging inclusivity. This acknowledgement of cultural diversity creates a sense of belonging and respect among learners, which is essential for the establishment of peaceful, egalitarian communities (Barton, 1996). In addition to promoting cultural awareness, ethnomathematical education improves critical thinking, problem-solving, and reflective reasoning by connecting mathematics to real-world situations, including environmental sustainability, community planning, and social justice issues (Gerdes, 1998). When students investigate mathematical concepts through the perspective of their cultural practices—such as indigenous measurement systems, architectural designs, or traditional trade—they enhance their mathematical comprehension and cultivate skills in dialogue, negotiation, and collaborative problem-solving. These qualities are crucial for constructively resolving interpersonal and social disputes, hence advancing the overall goals of peace education. Introducing indigenous and marginalised mathematical traditions into curricula helps in the integration of education, contesting dominant knowledge systems and validating voices previously marginalised in formal educational contexts (Rosa & Orey, 2016). By appreciating many epistemologies, educators enable learners to acknowledge the validity of other ways of knowing, promoting equity, empathy, and mutual respect. Ethnomathematical pedagogy converts classrooms into environments where mathematics serves as a conduit for intercultural comprehension and social unity. This approach is consistent with worldwide programs for sustainable peace, including UNESCO's promotion of education that encourages empathy, cooperation, and intercultural awareness (UNESCO, 2019). By adopting varied mathematical ideas,

educators may foster a generation of learners adept at navigating cultural disparities, participating in collaborative problem-solving, and contributing to cohesive societies. A further investigation is needed to investigate methods for expanding ethnomathematical approaches within both formal and informal educational settings, assessing their effects on promoting peace, social justice, and inclusive learning outcomes.

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CONSTRUCTION AND STANDARDIZATION OF TEST OF MATHEMATICS ACHIEVEMENT (TMA) FOR CLASS VIII STUDENTS

TBC Lalramnghaka[1], Dr. Prateek Chaurasia[2], Prof. Lokanath Mishra[3]
[1]*Research Scholar, Department of Education, Mizoram University, Mizoram, -796004*
[2]*Assistant Professor, Faculty of Education, Banaras Hindu University, Varanasi- 221010*
[3]*Professor, Department of Education, Mizoram University, Mizoram, -796004*

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ABSTRACT
The present study aimed to construct and standardize a Test of Mathematics Achievement (TMA) for Class VIII students to ensure a valid and reliable measurement of mathematical proficiency. The tool was developed following a systematic process that included content selection from the Mizoram Board of School Education (MBSE) syllabus, item construction based on Bloom's taxonomy, and expert validation. The TMA initially contained 35 multiple-choice items, which were piloted and analysed for item difficulty and discrimination. Following item analysis, 30 items meeting acceptable psychometric standards were retained. Reliability was established using the split-half and Kuder–Richardson (K-R 20) methods, yielding coefficients of 0.78 and 0.79, respectively, indicating high internal consistency. Content and construct validity were verified through expert judgment and theoretical alignment. The standardized TMA thus provides an effective tool for assessing mathematics achievement, facilitating pedagogical improvements, and supporting evidence-based educational practices, particularly in culturally responsive and ethnomathematical contexts.
KEYWORDS: *Mathematics, Mathematics Achievement, Standardization, Construction.*

INTRODUCTION

Mathematics has always been viewed as a fundamental part of human knowledge and an essential component of education at all levels. Often described as the language of science and technology due to its clarity, logical structure, and universal importance (Devlin, 2012), mathematics is more than just an academic subject. It is a vital life skill that supports rational decision-making, analytical thinking, and problem-solving in everyday life (Kilpatrick, Swafford, & Findell, 2001). It helps develop reasoning, abstract thinking, and systematic problem-solving abilities—skills that are crucial in the 21st century (Schoenfeld, 2016). As a result, math literacy has become a key indicator of a nation's educational standards and human capital development (OECD, 2019). At the school level, math education aims to build computational skills alongside conceptual understanding, reasoning, and an appreciation for the beauty and importance of mathematical ideas (NCTM, 2014). For middle school students, especially those in Class VIII, this stage marks an important shift from basic arithmetic to advanced reasoning involving algebra, geometry, and data analysis (Mullis et al., 2016). Establishing a strong foundation at this stage ensures readiness for further education and sustained numeracy (Anthony & Walshaw, 2009). Additionally, math fosters persistence, creativity, and metacognitive awareness—traits vital for academic success and personal growth (Boaler, 2016).

Mathematics, despite its global importance, is often regarded as a challenging and anxiety-provoking discipline by students (Ashcraft & Krause, 2007). Ineffective pedagogy, insufficient conceptual clarity, cultural attitudes, and poor learning assistance contribute to disparate accomplishment levels (Singh & Agarwal, 2017). International assessments such as PISA and TIMSS demonstrate enduring disparities in mathematics achievement, highlighting the necessity for evidence-based teaching and assessment methodologies (OECD, 2019; Mullis et al., 2016). Therefore, enhancing mathematics learning outcomes necessitates both new pedagogical approaches and reliable, accurate assessments to track student advancement and guide curricular development.

In this perspective, understanding mathematical achievement is crucial for improving the overall quality of schooling. By recognizing learning patterns and areas of difficulty, instructors can develop focused interventions that help improve knowledge. Enhancing mathematics proficiency at the basic level is essential for developing critical, creative, and flexible thinkers capable of succeeding in a progressively data-driven and technology environment.

Mathematics Achievement

Mathematics achievement defines the degree to which students attain knowledge, abilities, and comprehension in mathematics through instruction and educational experiences (Mullis et al., 2016). It serves as a measure of student cognitive development and

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is a crucial element of academic achievement. Success in mathematics is linked not just to academic skill but also to the capacity for logical thinking, problem-solving, and the application of mathematical reasoning in practical contexts (Kilpatrick, Swafford, & Findell, 2001). In the educational setting, mathematical proficiency is frequently assessed through tests and examinations aimed at evaluating students' understanding of curriculum objectives across several domains, including number systems, algebra, geometry, and statistics.

Numerous factors affect mathematics accomplishment, such as cognitive abilities, motivation, teacher effectiveness, instructional methodologies, socio-economic status, and cultural setting (OECD, 2019). Studies show that students engaged in concept-based and problem-oriented training have superior mathematical comprehension relative to those subjected to rote learning techniques (Boaler, 2016). Also, continuous assessment using valid and reliable tools allows educators to identify learning weaknesses and apply interventions to improve student performance (Nitko & Brookhart, 2014). Thus, accurately assessing mathematics achievement is essential for instructional enhancement and policy development.

In India, mathematics achievement is a significant issue due to noticeable performance disparities among students from different socio-economic and linguistic backgrounds (NCERT, 2021). The National Achievement Survey (NAS) and other national assessments indicate that numerous middle school students experience difficulties with conceptual understanding and application-oriented problem solving. Therefore, developing a standardized and psychometrically sound Test of Mathematics Achievement (TMA) is vital for ensuring objective evaluation along with equitable assessment processes. This tool assists teachers in identifying students' learning challenges and promotes effective teaching methods that improve overall proficiency in mathematics.

Need for the test of Mathematics achievement

In the field of educational research, the validity and reliability of assessment tools play a critical role in accurately measuring students' learning outcomes. The present study was designed to assess the effectiveness of ethnomathematical teaching strategies on the mathematics achievement of Class VIII students. To achieve this, the investigator developed the Test of Mathematics Achievement (TMA) specifically aligned with the objectives and context of the study. During the preliminary review of existing tools, it was observed that several standardized mathematics achievement tests have been developed for various educational levels; however, these tools were either based on different curricula or focused on cognitive dimensions that did not correspond to the present study's focus on ethnomathematics. Most of these available instruments primarily assess procedural and computational skills, neglecting the cultural and contextual aspects of mathematics learning (D'Ambrosio, 1985).

Given that the ethnomathematical approach emphasizes the integration of cultural practices, indigenous knowledge systems, and local problem-solving methods into the mathematics classroom, it became evident that conventional tests would not effectively measure the outcomes of such a pedagogy (Bishop, 1988; Rosa & Orey, 2016). The curriculum content, contextual relevance, and expected learning outcomes of Class VIII students in this study required an assessment tool that reflected both academic and cultural dimensions of mathematical understanding. Hence, the development of a new Test of Mathematics Achievement (TMA) was necessary to ensure content validity and to provide a comprehensive evaluation of students' conceptual understanding, problem-solving skills, and application of mathematical ideas within their cultural contexts. The construction of this test thus serves as a vital step in aligning assessment methods with the pedagogical innovation introduced through ethnomathematical strategies.

Purpose of the Study

The purpose of the study was to develop and validate a test of mathematics achievement (TMA) to evaluate mathematics achievement for class VIII students, carry out item analysis (difficulty and discrimination index), and estimate the reliability coefficient of the test of mathematics achievement.

Research Method

The present study is basically to design, develop, and validate a test of mathematics achievement. In the present study, an analysis of textbooks and syllabi was conducted, content selection was done, and items based on it were developed. Basically, it was an instrument in nature, and it was suitable to assess the mathematics achievement among the class VIII students. The descriptive survey research method is considered appropriate for this study as it would help to obtain first-hand information regarding the level of acquisition of mathematics achievement. The population comprised class VIII students of the Mizoram Board of School Education (MBSE) School in Mizoram state. The research sample used was made up of one hundred (100) students from the secondary school of the Aizawl district of Mizoram state.

Development and Standardization of Test of Mathematics Achievement (TMA).

EXPLORATORY STAGE

A. Selection of content for the test of mathematics achievement.

To determine the subject for mathematical achievement, the researcher examined the Mizoram board syllabus. After reviewing the curriculum and the textbook, the researcher identified the chapters and their respective content.

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Table:1
Selected Content

S.No.		Contents	No of items
1		**Understanding Quadrilaterals**	**6**
	a	Convex and concave polygons	1
	b	Angle sum property	1
	c	Sum of measures of exterior angles of a polygon	1
	d	Kind of quadrilaterals	1
	e	Angles of a parallelogram	1
	f	Some special parallelogram	1
2		**Practical Geometry: Constructing a Quadrilateral when**	**6**
	a	Length of four sides and the diagonal given	2
	b	Two diagonals and three sides given	1
	c	Two adjacent sides and three angles are known	1
	d	Three sides and two included angles are given	1
	e	Some special cases	1
3		**Data Handling**	**5**
	a	Grouping data	1
	b	Bar graph	1
	c	Circular graph	1
	d	Linking chance to probability	1
	e	Outcomes of an event	1
4		**Visualising Solid Shapes**	**6**
	a	Views of 3-D	3
	b	Faces, Edges, and Vertices	3
5		**Mensuration**	**6**
	a	Area of quadrilaterals	2
	b	Surface area of cube, cuboid, and cylinder	2
	c	Volume area of cube, cuboid, and cylinder	2
6		**Introduction to Graphs**	**6**
	a	A bar graph	1
	b	A line graph	1
	c	A pie graph (Circular graph)	1
	d	A histogram	1
	e	Co-ordinates	1
	f	quadrant	1
		Total	**35**

B. Identification of the Dimensions for the Construction of Items of Test of Mathematics Achievement.

Six dimensions of mathematical achievements were selected for the development of a test of mathematics achievement, and these dimensions have been previously discussed. Each item was prepared based on these dimensions from the selected contents.

PREPARATORY STAGE

A. Preparation of the items:

The primary objective of the mathematics achievement test is to assess the mathematical performance of eighth-grade students. The students' achievement is influenced by the teaching practices; therefore, measures were implemented to ensure that the items are designed to cover the topic selected for the test. The subsequent action was implemented in this context, and items were directly associated with the topic and aligned with the objectives of each unit. Items were specifically constructed in accordance with Bloom's taxonomy. All items were structured as multiple-choice questions, each presenting four distinct responses, of which one was correct.

Each question contains one accurate answer among four provided options. Upon completion of the test items, the initial copy was presented to specialists in mathematics education and educators instructing at the higher secondary level for their comments, feedback, and recommendations. Following expert suggestions and input, solutions to certain questions were revised, and the language was modified to enhance comprehension for learners; fortunately, all 35 items were retained in the second draft.

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B. Scoring

A scoring key was developed with the help of a mathematics teacher (PGT) by solving each question and determining the right answers, which the investigator later verified. Scoring was carried out carefully, assigning '1' for correct answers and '0' for incorrect answers.

C. Pilot Study

The initial draft of the Test of Mathematics Achievement (TMA) was carried out with a sample of 30 pupils in class VIII. The purpose of conducting the TMA was to examine the suitability of item difficulty, linguistic clarity, content adequacy, item design, statement simplicity, and learner accessibility.

After the administration of the TMA, the difficulties encountered by the students were documented to enhance the final draft. The pre-trial made it evident that the respondent provided instructions and clearly comprehended the language of the items. The perspectives of subject teachers about each item were also taken into account. All the items from the first drafts were retained in the second draft.

D. Second Draft of the Test

All items from the initial draft of the mathematics achievement test were retained in the second draft, with slight modifications to the language of those items considered unclear or difficult during the pre-try-out phase. The second draft of the tool comprised the following components:

- **Instructions for Administration**

An introductory statement was provided to articulate the objective and significance of the study, along with essential instructions for completing the test.

- **The Title of the Test**

The test was designed to assess mathematical achievement based on its content. A suitable title for the test was selected: **"Test of Mathematics Achievement (TMA)."**

THE DEVELOPMENT STAGE

A. Second Try Out of the Items

The test was administered to 100 students in person. The test instructions were read after they had been distributed. Examples were employed to illustrate the marking procedures. It was highlighted that no item should be omitted during the administration of TMA, and the respondents were requested and encouraged to provide an authentic response to each item.

B. Item analysis

Item analysis is a crucial step in the standardisation of any tool. Item analysis is a statistical method employed to choose or reject test items based on their discriminatory efficacy. Following pilot testing, the test underwent item analysis to identify which items were easy or difficult, as well as those that were malfunctioning (Stanley et al., 1978). Besides relevance, a commonly sought attribute for a test item is discrimination analysis. To obtain suitable items via item analysis, the researcher utilised 100 answer sheets from the selected sample. The individual's scores for all 100 samples were determined and organised from highest to lowest. The researcher subsequently selected the top 27% of the sample, comprising the high scorers, and the bottom 27%, consisting of the low scorers.

C. Item Selections

Difficulty Index of an Item

The difficulty index of an item is shown by the percentage of students who answered it correctly. The formula is given below.

$D.I. = U + L/2N$

Where, U is the number of correct answers in the upper group

L is the number of correct answers in the lower group

N is the number of students in both groups.

Discrimination Power of an Item

The discriminating power of an item measures its ability to differentiate between individuals who perform well on the overall test and those who do not. It distinguishes between those possessing the measured attribute and those lacking it. In this particular situation, the characteristic is " mathematics achievement. The item's discriminative power was computed using the formula.

$D.P. = U – L/N$

Where, U is the number of correct answers in the upper group

L is the number of correct answers in the lower group

N is the number of students in both groups.

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Selection of Items

From the above-mentioned reasons and formulas, the difficulty index and discrimination power of each TMA item were calculated. Any item with a discriminating power over 0.30 should be regarded as a sufficiently effective item (Ebel, 1966). In this experiment, only items with difficulty indices between 0.25 and 0.75 and a discriminating power over 0.40 were selected. Table 2 lists the specifics of this exercise.

Table:2

Table showing the 'D.I.' and 'D.P. Values obtained from Item analysis and selected items for the test of mathematics achievement

Item	D.I.	A/R (0.25-0.75)	D.P.	A/R (0.40 and above)	Result
Item no. 1	0.26	**A**	0.44	**A**	**A**
Item no. 2	0.65	**A**	0.41	**A**	**A**
Item no. 3	0.44	**A**	0.52	**A**	**A**
Item no. 4	0.54	**A**	0.41	**A**	**A**
Item no. 5	0.46	**A**	0.48	**A**	**A**
Item no. 6	0.78	**R**	0.07	**R**	**R**
Item no. 7	0.46	**A**	0.41	**A**	**A**
Item no. 8	0.54	**A**	0.48	**A**	**A**
Item no. 9	0.44	**A**	0.59	**A**	**A**
Item no. 10	0.56	**A**	0.44	**A**	**A**
Item no. 11	0.91	**R**	-0.11	**R**	**R**
Item no. 12	0.26	**A**	0.52	**A**	**A**
Item no. 13	0.52	**A**	0.44	**A**	**A**
Item no. 14	0.61	**A**	0.41	**A**	**A**
Item no. 15	0.35	**A**	0.41	**R**	**A**
Item no. 16	0.59	**A**	0.59	**A**	**A**
Item no. 17	0.96	**R**	-0.07	**R**	**R**
Item no. 18	0.48	**A**	0.52	**A**	**A**
Item no. 19	0.46	**A**	0.41	**A**	**A**
Item no. 20	0.61	**A**	0.41	**A**	**A**
Item no. 21	0.93	**R**	0.15	**R**	**R**
Item no. 22	0.69	**A**	0.41	**A**	**A**
Item no. 23	0.52	**A**	0.44	**A**	**A**
Item no. 24	0.61	**A**	0.41	**A**	**A**
Item no. 25	0.50	**A**	0.41	**A**	**A**
Item no. 26	0.54	**A**	0.41	**A**	**A**
Item no. 27	0.59	**A**	0.44	**A**	**A**
Item no. 28	0.31	**A**	0.48	**A**	**A**
Item no. 29	0.48	**A**	0.59	**A**	**A**
Item no. 30	0.50	**A**	0.41	**A**	**A**
Item no. 31	0.57	**A**	0.41	**A**	**A**
Item no. 32	0.80	**R**	0.26	**R**	**R**
Item no. 33	0.65	**A**	0.41	**A**	**A**
Item no. 34	0.61	**A**	0.48	**A**	**A**
Item no. 35	0.50	**A**	0.41	**A**	**A**

Note: A- denotes the items accepted; R- denotes the items not selected/rejected.

The table indicates that precisely 30 items were selected and retained for the final test. Therefore, after the item was analysed, a total of 5 items were removed from the test, resulting in a final draft of the TMA comprising 30 items.

FINAL STAGE

A. Time Limit

During the exploratory phase, respondents were allocated 40 minutes. During the administration of the second draft, it was observed that the majority of respondents completed the questions within 30 minutes. Consequently, a duration of 35 minutes was designated for the last stage of the test.

Reliability and Validity of the Test of Mathematics Achievement

In the present study reliability of the test of mathematics achievement (TMA) has been established with the help of two methods, split half reliability method and K-R 20 reliability method. The results are presented below.

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Table:3

Measuring tool	Reliability coefficient	
Test of Mathematics Achievement	Split-half	K-R 20
Value of reliability coefficient	0.78	0.79

Validity of Test of Mathematics Achievement

Reliability denotes the precision of a measurement, while validity addresses whether a measurement accurately assesses what it purports to measure. Kerlinger (1973) identified content validity as the most significant among the three categories of validity, since they relate to the extent to which specific explanatory constructs may account for respondents' performance on a particular measure. Consequently, to ascertain the validity of the TMA, content validity was established.

(a) Content validity

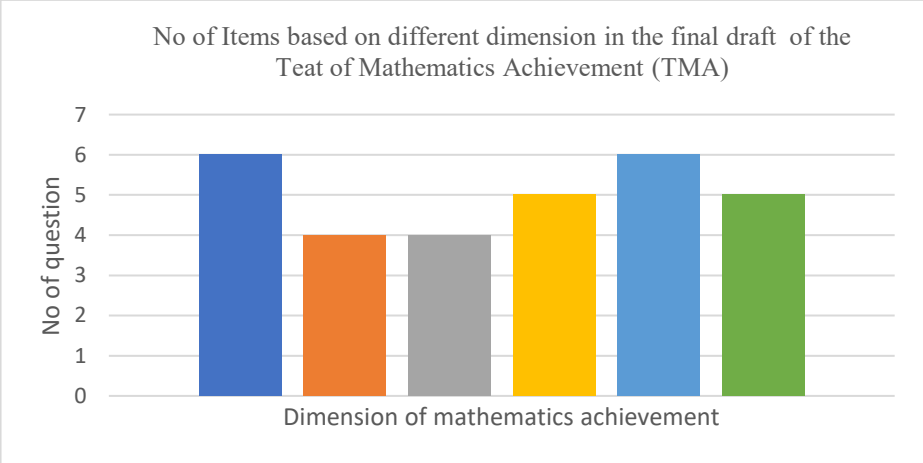
Content validity is a primary indicator that enables us to assert the purpose of the test's content, specifically what the test assesses. The extent to which a test's content accurately reflects the domain it is intended to assess. Content validity fundamentally relies on the assessment of experts within the discipline. The content validity of the test of mathematics achievement was determined based on the judgments and feedback of specialists in education, mathematics, and mathematics education. The primary objective of an achievement test is to assess the extent to which students have acquired the content. So, according to Best & Kahn (2006), content validity is deemed optimal for these categories of tests. Experts from each discipline were selected to validate the test. All items were evaluated by experts from various fields, who assessed their content relevance and deemed them appropriate. Additionally, the significance of the items was tested during the initial trial.

Therefore, the 'Test of Mathematics Achievement' might be considered to have sufficient content validity.

Number of Items Based on Different Dimensions in Final Draft of Test of Mathematics Achievement (TMA)

Table:4

S.No.	Contents	No of items
1	Understanding Quadrilaterals	**6**
2	Practical Geometry	**4**
3	Data Handling	**4**
4	Visualising Solid Shapes	**5**
5	Mensuration	**6**
6	Introduction to Graphs	**5**



Final Draft of the Test of Mathematics Achievement (TMA)

The final format of the mathematics achievement test comprises 30 multiple-choice questions. One mark is awarded for each correct answer and zero marks for each incorrect response. The test has a maximum score of 30 and a minimum score of 0. The time limit for completing the full test is 35 minutes.

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ABSTRACT

MATHEMATICS LEARNING AMONG MIZO TRIBE: AN ETHNOMATHEMATICAL STUDY

AN ABSTRACT SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

TBC LALRAMNGHAKA

MZU REGISTRATION NUMBER: 6882 of 2014

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MATHEMATICS LEARNING AMONG MIZO TRIBE: AN ETHNOMATHEMATICAL STUDY

By

TBC Lalramnghaka

Department of Education

Supervisor : Prof. Lokanath Mishra

Co-Supervisor : Dr. Prateek Chaurasia

Submitted

In partial fulfillment of the requirement of the Degree of Doctor of Philosophy in Education of Mizoram University, Aizawl.

ABSTRACT

Introduction

Mathematics is the universal language of logic, patterns, and relationships that helps us understand the world around us. At its core, mathematics is founded on fundamental truths that remain constant across time and cultures. Mathematics is a discipline of absolute certainty within its formal systems because it is based on axioms, definitions, and deductive reasoning, in contrast to empirical sciences that depend on observation and experimentation (Hersh, 1997). Since its conclusions are based on rigorous proof rather than physical reality, mathematical propositions are guaranteed to be eternally valid once they have been validated (Hardy, 1940). This feature sets mathematics apart from other disciplines because, unlike scientific theories, its conclusions are not subject to change. The basic ideas behind maths were structure, order, and logic. It followed rules and used symbols to make ideas clear and correct. Mathematicians used logic to look into ideas and find the truth. Definitions, theorems, and proofs made up the subject. These parts helped to explain why something was true, not just what the answer was (Bishop, 1988). It helped people think deeply and see how different things were connected. Mathematicians often got their ideas from patterns they saw in nature or in how people acted (Zaslavsky, 1999).

Mathematics in India has consistently occupied a significant position, both historically and in contemporary schooling. Ancient Indian intellectuals such as Aryabhata and Brahmagupta produced significant advancements in algebra, arithmetic, and astronomy as early as the 5th century (NCERT, 2005). In modern India, mathematics is a fundamental topic in the educational curriculum, influenced by national education policies and committees. The National Curriculum Framework (NCF) 2005 underscored the transition from rote memorisation to conceptual comprehension, promoting the teaching of mathematics as a means of logical reasoning rather than simple recall (NCF, 2005). The Yash Pal Committee Report (1993) emphasised that mathematics instruction frequently prioritised rote problem-solving, instilling anxiety and aversion in children (Yash Pal Committee, 1993). The disjunction between policy and practice constituted a continual issue in Indian education. The Indian National Education Policy 2020 acknowledges mathematics as an essential discipline that fosters logical reasoning and problem-solving skills (Ministry of Education, 2020). This supports the perspective that mathematics encompasses not just

numbers and computations but also structured thinking and analytical abilities. The National Curriculum Framework 2005 underscores that mathematics needs to be taught as a mode of thinking rather than merely a compilation of formulae (NCERT, 2005).

Modern research on schooling demonstrates that students naturally learn how to think mathematically by interacting with the world around them (National Research Council, 2009). The National Education Policy 2020 builds on this by saying that students should learn maths via activities and experiences (Ministry of Education, 2020). This method understands that arithmetic skills aren't something you are born with, but something you can learn via the right kinds of stimulus and practice. Ultimately, mathematics was simultaneously straightforward and profound. It begins with fundamental notions such as enumeration and progresses into the most intricate domains of human cognition. It was sufficiently pragmatic to construct bridges and sufficiently abstract to investigate hypothetical realms. Bertrand Russell characterised mathematics as a discipline in which we are perpetually uncertain about the subject matter and the veracity of our statements (Russell, 1901). The prospects of mathematics education in India hinge on reconciling tradition with innovation. Simultaneously, digital technologies and AI offered novel prospects for personalised learning, as outlined in the NEP 2020. The objective was to position mathematics not as an obstacle but as an avenue to intellectual curiosity and innovation.

Teaching learning nowadays also involves the deliberations of issues related to society and culture, and their impact on the educational process. Ethnomathematics, in consonance with mathematics education, goes on to explore the facts of mathematics learning that include cultural and social processes. Ethnomathematics was defined by D'Ambrosio (1985) as "Ethnomathematics is the mathematics which is practiced among identifiable cultural groups such as national-tribe societies, labor groups, children of certain age brackets, and professional classes." If we draw attention to different cultural groups, it has been studied that they have their specific ways of obtaining their practical mathematics. Ethnomathematics explores the diverse expressions of mathematical ideas. This study aims to develop an ethnomathematics approach from the traditional activities of the Mizo community and validate in the classroom.

Theoretical Framework

The present study, "Mathematics Learning among Mizo Tribe: An Ethnomathematical Study," is grounded in the theoretical integration of Ethnomathematics Theory (D'Ambrosio, 1985), Sociocultural Theory (Vygotsky, 1978), and Constructivist Learning Theory (Piaget, 1970; Bruner, 1966). These theories collectively provide the foundation for understanding how mathematical knowledge is embedded in the culture of the Mizo tribe and how it can be meaningfully incorporated into classroom teaching. Ethnomathematics, as introduced by D'Ambrosio (1985), emphasizes that mathematics is a human activity rooted in cultural contexts, developed as people seek to explain, understand, and organize their environment. It challenges the view of mathematics as universal and culture-free, asserting instead that each community possesses its own mathematical systems shaped by social practices and worldviews (Rosa & Orey, 2011). This perspective is particularly relevant to exploring the mathematical elements present in Mizo cultural artifacts and daily life activities, such as bamboo weaving, house construction, and agricultural measurement, which inherently reflect geometric reasoning, pattern formation, and estimation (Gerdes, 1996; Palhares & Rosa, 2021).

Complementing this, Vygotsky's (1978) Sociocultural Theory highlights that learning occurs through social interaction and participation within cultural settings. Knowledge is not transmitted mechanically but co-constructed through communication, apprenticeship, and shared activities (Cole, 1996). Among the Mizo community, traditional mathematical practices are transmitted informally through generational teaching, reflecting Vygotsky's concept of the Zone of Proximal Development (ZPD), where learners acquire knowledge by interacting with more skilled members of society. Applying this lens to the classroom, the study views the integration of cultural mathematical practices as a way to scaffold learning and promote culturally responsive pedagogy. Also, Constructivist Learning Theory (Piaget, 1970; von Glasersfeld, 1995) supports the notion that learners actively construct knowledge based on prior experiences. When students relate cultural activities to classroom mathematics, they build new conceptual understanding through experiential engagement (Fosnot, 2005). Therefore, developing ethnomathematical lesson plans for Class VIII students allows learners to construct mathematical meaning rooted in their own cultural context. Collectively, these three theoretical perspectives explain how mathematics learning among the Mizo tribe is both culturally mediated and cognitively

constructed, emphasizing the importance of integrating indigenous knowledge into formal education to enhance understanding, engagement, and achievement in mathematics.

Rationale of the Study

Ethnomathematics is the study of how mathematics and culture interact in mathematics education. Typically connected with "cultures without written expression," it may alternatively be described as "the mathematics which is practiced among identified cultural groupings" (D'Ambrosio, 1985; Gerdes, 1996). It covers a wide range of concepts, from various mathematical and number systems to multicultural mathematics education. Ethnomathematics seeks to further both the understanding of culture and of mathematics, primarily by highlighting the relationships between the two (Rosa & Orey, 2011). In their book *Mathematics Education*, Narlikar and Bhimasankaram (1979) claim that the fundamental issue in mathematics is well known to its novices in their own ways and practices. If we regard primary students as first beginners and then as second-level beginners, there is a need to establish an ethnomathematical method for upper primary-level pupils. According to the National Curriculum Framework (2005), there are four main issues with classroom mathematics instruction, one of which is that the problems, exercises, and methods of evaluation are repetitive and mechanical, with an excessive focus on calculation. Mathematical concepts like spatial reasoning are not adequately covered in the curricula. Students at the upper primary level experience mathematics' power for the first time through the use of potent abstract concepts that condense prior knowledge and experience. This gives them the chance to review and consolidate the fundamental ideas and abilities they learned in the primary stage, which is crucial for achieving universal mathematical literacy. Education at this point provides a chance for children to improve their spatial thinking and visualization abilities (NCF, 2005).

The purpose of this study is to have a better understanding of how the Mizo tribes used mathematics in their earlier days and how mathematics influenced their life. Though they might not have been aware that they were using mathematics, in reality, mathematical ideas played an important role in their daily life (Saxe, 1991). Long before formal education existed, mathematical reasoning was integrated into cultural practices that supported their livelihood. Research in the field of ethnomathematics is still limited, especially among the Scheduled Tribes in India. Conducting such research can be productive and useful for the present generation, since it helps preserve indigenous knowledge systems and highlights the

role of traditional mathematical thinking in sustaining communities (Rosa & Orey, 2016; Palhares & Rosa, 2021).

Mizo culture has a deep linkage with mathematics, evident in the making of useful equipment from bamboo, clay, and other natural materials using geometric concepts—such as square-based baskets, bamboo stools, mats, clay pots, crab traps, and winnowing trays (Lalnundanga, 2018). Thus, the study of mathematics learning among Scheduled Tribes, by investigating the cultural or traditional activities of Indian ethnic groups, is a significant concern for the mathematics education research community (Mukhopadhyay et al., 2009).

Statement of the Research Problem

The purpose of the study was to investigate the mathematical characteristics present in the culture of the Mizo Tribes and their potential application to the field of mathematics. Thus, the study is formally entitled 'Mathematics Learning among Mizo Tribe: An Ethnomathematical Study'.

Operational Definition of the Key Terms Used

Mathematics Learning

Mathematics learning (Verschaffel, L., Van Dooren, W., De Smedt, B.,2019) can be broadly defined as acquiring new knowledge, skills, and effects related to quantity, space, computation, numeracy, and structure.

Mathematics learning in the present study refers to the conceptual understanding of various concepts of mathematics prescribed in school mathematics textbooks.

Ethno-Mathematics

Ethnomathematics is the study of how mathematics and culture interact in mathematics education. Typically connected with "cultures without written expression", it may alternatively be defined as "the mathematics which is practiced among identified cultural groupings" (D'Ambrosio, 2001).

Ethnomathematics in the present study means the study of mathematics and its intercept on day-to-day life with the customs and culture of the Mizo tribe.

Mizo Tribe

The Mizo tribe refers to a collective of indigenous individuals who mostly reside in the northeastern Indian state of Mizoram, as well as in adjacent areas of Myanmar and

Bangladesh. They are part of the broader Tibeto-Burman language family and are recognised for their own cultural identity, traditional practices, and community way of life. Their civilisation has transitioned from a tribal chiefdom to a contemporary democratic framework (Zama, 2011). The Mizo culture is abundant in oral traditions, festivals, and artisanal skills, particularly in bamboo handicrafts. Mizoram's 95% of the population is of tribal origin. By Article 366 (25) in the Constitution of India, they have the status of a Scheduled Tribe (ST).

In the present study, Mizo tribes refer to the indigenous tribal people of Mizoram, commonly known as Mizos.

Research Questions

The study aimed to determine the three key questions as follows:

1. What kind of mathematical elements does Mizo culture have?
2. How can these elements be utilized to enhance and promote mathematics learning among students of different grades?
3. Which mathematical concepts at the elementary level would apply to the traditional activities of the Mizo tribe, and how would that be applicable in the teaching and learning process of mathematics? (As an Ethnomathematics approach)

Objectives of the Study

1. To study the mathematical elements which exist in the culture of the Mizo tribe.
2. To identify the different mathematical activities embedded among different cultural materials of the Mizo tribe.
3. To identify the connotation of mathematical concepts at the Class VIII level with existing cultural mathematical elements of the Mizo tribe.
4. To develop ethnomathematical lesson plans for Class VIII students.
5. To study the effect of ethnomathematical teaching strategies on mathematics achievements among Class VIII students.

Variables of the Study

Independent Variable

The present study involves one independent variable. The teaching method, i.e., ethnomathematical teaching strategies and traditional teaching methods, served as an independent variable.

Dependent Variable

The dependent variable, which was taken as a criterion of the effect of treatment, is mathematical achievement. The purpose of obtaining the variables was to determine the alteration in students' mathematical achievement results from the treatments.

Hypotheses

Research Hypotheses

H_1: An Ethnomathematical Lesson Plan can have a significant effect on the mathematics achievement of Class VIII students

Null Hypotheses

H_0: There is no significant effect of the ethnomathematical lesson plan on the mathematics achievement of Class VIII students.

Review of Related Literature

The literature on ethnomathematics reveals a rich body of work that highlights the interplay between mathematics, culture, and education across different communities worldwide. Early works such as those of Fasheh (1980) and Panda (2006) emphasised how mainstream mathematics education often fails to resonate with learners from indigenous or marginalised groups because it overlooks cultural knowledge systems. These studies set the stage for subsequent inquiries that demonstrated how deeply mathematics is embedded in cultural practices—from counting, measuring, and pattern recognition to architectural designs and traditional games. Research from different contexts (e.g., Kabihug tribe in the Philippines, Baduy culture in Indonesia, and Jambi wedding traditions) consistently shows that integrating cultural practices into formal mathematics instruction makes learning more meaningful and relevant, thereby enhancing engagement and performance.

Across many studies, a shared finding is that ethnomathematics improves motivation, comprehension, and problem-solving ability. For example, Rubio (2016), Septianawati et al. (2017), and Pramudita & Rosnawati (2019) illustrated how indigenous practices such as weaving, batik design, and everyday measurement systems can be translated into school mathematics. More recent studies like those by Az-Zahroh et al. (2019) and Richardo et al. (2023) demonstrated how combining ethnomathematics with technology (augmented reality, e-books, or educational apps) enriches learning, making

abstract concepts more accessible while preserving cultural heritage. Similarly, problem-based learning (PBL) models and STEAM approaches grounded in ethnomathematics (e.g., Zaenuri et al., 2020; Hartini & Dafik, 2023; Guido David et al., 2024) reveal that students develop stronger creative and critical thinking abilities when culture is embedded in teaching strategies.

Despite these positive outcomes, several comparative insights emerge. First, there is a tension between preservation and adaptation. Studies such as Alangui (2020) caution against decontextualising or "colonising" cultural knowledge when integrating it into formal curricula. This contrasts with works like Prahmana (2019) or Pramudita & Rosnawati (2019), which show how cultural practices can be effectively adapted to modern classrooms. The implication is that ethnomathematics integration must strike a balance between authenticity and pedagogical practicality. Second, there is a divergence in teacher readiness and perceptions. While some educators see ethnomathematics as a powerful pedagogical tool (Acharya et al., 2021; Purwanto et al., 2025), others report hesitancy, citing challenges in adaptation, communication, and curriculum demands (Özcan & Bahadır, 2024). This indicates that teacher professional development and curriculum design need stronger alignment with cultural mathematics approaches. Third, there is unevenness in research coverage. Geometry, measurement, and patterns dominate the literature (Hendriyanto et al., 2023), while areas such as algebra, statistics, and higher-order mathematical reasoning remain underexplored in cultural contexts. Additionally, most studies focus on Asian and African communities, with fewer from Western or cross-cultural environments, despite increasing multicultural classrooms globally.

Findings converge on the fact that ethnomathematics strengthens students' mathematical literacy, cultural appreciation, and cognitive growth. From traditional games like engklek in Indonesia to architectural explorations of temples, mosques, and houses across regions, studies highlight how everyday life provides authentic contexts for learning. Ethnomathematics also extends to character education (e.g., wayang puppet studies), ecological awareness (e.g., waste management in Surabaya), and digital innovation, underscoring its multidisciplinary potential. The overall body of literature demonstrates that ethnomathematics serves not only as a pedagogical approach but also as a mechanism for cultural preservation. It bridges the gap between abstract mathematical concepts and real-world applications, ensuring learning is contextual, engaging, and socially relevant.

However, several challenges remain. To advance ethnomathematics, a multi-faceted approach is essential. This requires strengthening teacher preparation to equip educators with the skills for authentic integration, while broadening research into underexplored mathematical domains and comparative international studies. Leveraging technology through tools like AR and gamified platforms can enhance scalability and engagement. Crucially, these efforts must be underpinned by cultural sensitivity, which can be ensured through community participation to avoid misrepresentation. Ultimately, ethnomathematics should be strategically linked to wider educational objectives, framing it as a vital pathway for developing not only mathematical literacy but also creative thinking, sustainability, social identity, and intercultural understanding.

Research Gap

The reviewed literature clearly establishes that ethnomathematics serves as a meaningful bridge between mathematical concepts and learners' cultural experiences, enhancing comprehension, creativity, and engagement. Numerous studies have explored ethnomathematical practices among various indigenous groups such as the Baduy, Kabihug, Sasak, and Tangkhul tribes, revealing how counting, measuring, patterning, and spatial reasoning are embedded in daily life, architecture, art, and rituals. However, most of these studies are concentrated in regions such as Indonesia, the Philippines, and Africa, with limited attention to tribal communities in Northeast India. Although Indian scholars like Panda (2006) and Singh et al. (2019) have discussed the general challenges of mathematics learning among tribal learners, there remains a significant gap in documenting, interpreting, and integrating the mathematical practices of the **Mizo tribe** within formal education.

The literature highlights methodological limitations—many studies describe cultural artefacts but seldom connect them to cognitive learning processes or pedagogical frameworks. There is a lack of systematic investigation into how ethnomathematical knowledge can be aligned with contemporary curricula to improve learning outcomes among indigenous learners. No comprehensive ethnomathematical study has yet examined the **Mizo people's** traditional practices, numeration systems, spatial designs, and problem-solving methods in relation to mathematics education. Addressing this gap will contribute not only to preserving local knowledge but also to developing culturally responsive mathematics instruction that fosters meaningful learning, equity, and inclusion among Mizo students.

Methodology of the Study:

This study employed a two-phase, i.e., exploratory (QUAL–QUAN) research methodology to empirically examine the research question.

1. In the first phase of the study, an **exploratory survey** was done to identify the elements of mathematics and its different aspects existing in the culture of the Mizo tribes. This phase included the interview of some of the identified indigenous Mizo people and educated Mizo professionals in research and teaching. Along with this, an interview schedule was used to observe the same.
2. In phase two, a **quasi-experimental** (pre-test non-equivalent control group design) technique was used to study the effectiveness of the identified mathematical elements of Mizo culture on the mathematics achievement of Class VIII students.

Groups	Pre-Test		Treatment	Post-Test
A	O1	→	C	O2
B	O3	→	X	O4

Where: A= Control Group, B= Experimental group, C= Conventional Method of Teaching, X= Ethnomathematical Lesson plan-based teaching strategies Approach, O1& O3= Pre-test, and O2 & O4= Post-test.

Population

Phase-I

The indigenous people of the Mizo Tribe of Mizoram, who are involved in their traditional activities (*like making a square base small basket, bamboo stool, winnowing tray, crab trap, and Mizo bow*) and educated professionals, especially in research and teaching from Mizoram, were the population for the first phase of the study.

Phase-II

The research population comprised class VIII students enrolled in the Mizoram Board of School Education (MBSE) in Aizawl City for the academic year 2024-2025.

Sample

Phase-I

For the first phase, five (5) indigenous groups of 7 to 8 people (who are involved in their traditional activities) of the Mizo Tribe from each District of Mizoram were selected as a sample with the help of a purposive random sampling technique. The researcher visited the Mizoram State Museum for clarification of the English names of the indigenous materials. Also, educated professionals in research and teaching from Mizoram University were selected using a purposive sampling technique.

Phase-II

For the second phase, the researcher has taken a School, where two sections (control and experimental) are available. Since the prepared lesson plan is based on the dimensions of ethnomathematics and to minimize the interaction effect during the experiment, two different sections (A and B) from one school, having the same learning environment and the same standards, have been taken.

Due to practical challenges, unavailability, and lack of cooperation from schools in randomising classrooms, the researcher was forced to execute this experiment only in those schools that were cooperative. Consequently, purposive sampling was employed to choose the school. The study sample comprised 90 students from sections A and B of the school in Aizawl. All of these students were registered in class VIII for the 2024-2025 academic session. The school prohibited the random assignment of students into groups. Thus, the researcher was compelled to experiment on an intact group present in the schools. The assignment of control and experimental groups was conducted randomly using the lottery technique. Using Helen Lowry School under MBSE as a sample, Section B has been designated as the experimental group, while Section A serves as the control group.

Distribution of the sample

School	Section	Group	N
Helen Lowry School	A	Control	45
	B	Experimental	45

Instruments/Tools used in the Study

Phase-I

Interview Schedule

A self-constructed interview schedule was used for a comprehensive study on the mathematical aspects inherent in the culture of the Mizo tribe, accompanied by methodical observational procedures. The interview schedule encompasses two components: Biographic Information and Mizo cultural elements.

Phase-II

Mixed Group Test of Intelligence (MGTI)

The current test was developed by Dr. P.N. Mehrotra and comprises two components: verbal and non-verbal examinations. Each component contains fifty items structured in an omnibus selected format, and this assessment is suitably referred to as a mixed intelligence test. This was utilised to assess the IQ of pupils aged 12 to 17 years. Consequently, the test was determined to be appropriate for eighth-grade students. The split-half, test-retest, and Kuder-Richardson reliability coefficients of the complete test were determined to be 0.88, 0.86, and 0.85, respectively.

Test of Mathematics Achievement

The Test of Mathematics Achievement (TMA) was developed to measure the mathematical proficiency of eighth-grade students. The achievement of students is influenced by the implementation of ethnomathematical teaching strategies through the lesson plan; hence, precautions were taken to construct the items to encompass the content selected for the development of the lesson plan. The test has 30 multiple-choice questions. One mark is awarded for each correct answer and zero marks for each incorrect response. The test has a maximum score of 30 and a minimum score of 0. The split-half reliability of the test was determined to be 0.76, while the Kuder-Richardson 20 reliability was 0.79.

Ethnomathematical Lesson Plan

Preparation of an Ethnomathematical lesson plan is done in the following stages

1. Identification of the content and topic
2. Identification of Mizo cultural aspects
3. Materials used in the Mizo day-to-day life
4. Preparation of components of the lesson plan with pedagogical aspects

5. Development of ethnomathematical lesson plans
6. Validation of ethnomathematical lesson plans
7. Pilot testing of ethnomathematical lesson plans
8. Development of final ethnomathematical lesson plans

Semi-Structured Interview Schedule (for students)

The semi-structured interview schedule has 10 open-ended questions, all of which highlight the key components of teaching strategies of the lesson plans, including activities, assessments, and experiences associated with learning mathematics through an ethnomathematical lesson plan. After concluding the experiment, a semi-structured interview schedule was employed to gather the mathematics learning experiences of the experimental group students. The questions in the semi-structured interview schedule have been categorized into four distinct groups relating to the learning associated with the teaching strategies outlined in the lesson plans

Data Analysis

Phase-I

Qualitative data analysis was employed to analyse the evidence from the first phase of the study, using the Miles & Huberman (1994) model of qualitative data analysis.

Phase-II

Descriptive statistics, including mean, median, mode, and standard deviation, along with inferential statistics such as ANCOVA (Analysis of Covariance), were employed for data analysis and deriving significant inferences relevant to the study's objective. Data coding and entry were performed using Microsoft Excel, while further data analysis was conducted using SPSS version 27.

Findings of the Study

This section provides a summary of the findings obtained from the analysis and interpretation of the data. The main findings of the study, categorised by objectives and aligned with the hypotheses, are as follows:

Findings related to objective 1:

Objective No.1: To study the mathematical elements which exist in the culture of the Mizo tribe.

The objectives aim to study the 71 mathematical elements that exist in the culture of the Mizo tribe. The diverse range of Mizo indigenous materials reflects the community's rich cultural heritage and its strong bond with the environment. These traditional artefacts, comprising household utilities, agricultural equipment, musical instruments, and storage vessels, highlight the integration of practical knowledge and creativity in Mizo daily life. Artefacts such as Aiawt (crab trap), Arbawm (chicken basket), and Ngaawt (fish basket) exemplify sustainable practices of food collection and animal rearing rooted in local ecology. Agricultural implements such as the Favah (sickle), Tuthlawh (hoe), and Suk (pestle) exemplify indigenous knowledge systems that support livelihood practices. Domestic tools, including the Baibel (an earthen pot), Buhherkhawl (a wooden mortar), and Maufian (a bamboo spoon), exemplify the community's dependence on natural resources like bamboo, wood, and clay, highlighting their environmentally sustainable habits. Artistic and recreational components such as the Phenglawng (bamboo flute), Tawtawrawt (bamboo trumpet), and Khuangpui (large drum) underscore the cultural importance of music and oral traditions in fostering communal cohesiveness. Moreover, elements such as the Mizo (typical Mizo house) and Tapchhak (fireplace) exemplify architectural acumen and domestic arrangement. These materials collectively represent mathematical, ecological, and cultural aspects, making them essential for ethnomathematical research and pedagogical incorporation, thus connecting traditional techniques with modern learning.

Findings related to objective 2:

Objective No.2: To identify the different mathematical activities embedded among different cultural materials of the Mizo tribe.

The study's objectives emphasise the significance of recognising mathematical principles inherent in the traditional artefacts of the Mizo tribe. A wide variety of traditional tools, domestic objects, musical instruments, and agricultural implements demonstrates profound mathematical understanding, particularly in geometry, measurement, and symmetry. Common items such as baskets, pots, stools, plates, spoons, and traps exemplify the application of geometric forms, including cylinders, cones, spheres, cuboids, and hemispheres, as well as the concepts of volume, capacity, and proportion. Baskets and traps

exemplify the use of cylindrical and conical structures, whereas cooking utensils and jars frequently integrate circular and hemispherical forms to optimise space and functionality.

Musical instruments like drums, trumpets, and flutes incorporate cylindrical and conical shapes to generate sound, so connecting mathematics with acoustics. Weaving, spinning, and textile production exemplify patterns, symmetry, and measurement in design, whereas implements such as sickles, hoes, and axes demonstrate applied geometry through their triangular and curved configurations. Children's toys, such as spinning tops, bamboo guns, and stilts, offer amusement while illustrating principles of balance, rotation, and motion based on mathematical reasoning. These cultural customs demonstrate the community's instinctive utilisation of mathematics in their daily activities without formal education. Utensils like measuring bowls, pestles, mortars, and sieves demonstrate practical understanding of dimensions, capacity, and proportions, whereas traps for avian, aquatic, and rodent species exemplify problem-solving via geometric design and mechanical equilibrium. Housing and furniture exemplify mathematical principles by employing cuboidal, triangular, and cylindrical shapes for stability and proportion.

These objectives emphasise that mathematics is fundamentally embedded in the traditions of the Mizo people. Their cultural artefacts fulfil functional and aesthetic functions while also embodying inherent mathematical concepts. Identifying these characteristics can enhance ethnomathematical pedagogies, rendering education more significant by linking classroom concepts to real-life situations.

Findings related to objective 3:

Objective No.3: To identify the connotation of mathematical concepts at the Class VIII level with existing cultural mathematical elements of the Mizo tribe.

The third objective of the study aims to investigate the connotation of mathematical concepts at the Class VIII level by including cultural mathematical aspects from the Mizo tribe. The investigation demonstrated that the traditional artefacts and practices of the Mizo culture embody a diverse array of mathematical concepts, especially in the areas of geometry and mensuration. Cultural artefacts, including baskets, pots, drums, and tools, exemplify geometric shapes such as cylinders, cones, spheres, cuboids, hemispheres, and ovals, which correspond directly with the mathematical concepts presented in the educational curriculum. Cylindrical objects elucidate surface area and volume, conical shapes facilitate an

understanding of cone qualities, while round and hemispherical objects illustrate circumference, area, and three-dimensional visualization.

The findings show that these cultural artefacts offer practical frameworks for intricate mathematical concepts, making abstract mathematics more easily accessible and significant. Linking classroom instruction with concrete cultural artefacts enhances students' ability to visualise forms, measure dimensions, and calculate perimeter, area, and volume. The objects provide possibilities to illustrate symmetry, angles, parabolic curves, and line intersections, so connecting practical experiences with theoretical concepts. The cultural context enhances understanding and cultivates cultural pride by emphasising the mathematical knowledge inherent in indigenous activities.

The objective emphasises the educational significance of ethnomathematics in connecting local culture with formal education. The integration of traditional artefacts as instructional tools increases experiential learning, engages students through familiar situations, and augments the curriculum with cultural significance. The connotation of mathematical concepts, grounded in the lived experiences of the Mizo tribe, enhances comprehension, improves retention, and facilitates meaningful application of mathematics in everyday life

Findings related to objective 4:

Objective No.4: To develop ethnomathematical lesson plans for Class VIII students.

The fourth objective of this research focuses on the systematic development of an Ethnomathematical lesson plan. The approach is systematic and consists of eight separate, sequential stages to ensure educational integrity and cultural authenticity.

The initial phase comprises a fundamental identification of the mathematical content and relevant Mizo cultural elements, ensuring an intrinsic connection between the curriculum and local tradition. This is followed by the collection of resources from Mizo daily life to provide concrete, relatable educational tools. The core activity is the preparation and development of the lesson plan's components, carefully integrating suitable pedagogical strategies.

The produced lesson plans are not deemed final upon their initial development. They undergo a severe validation process to verify their quality and accuracy, followed by practical pilot testing to measure their effectiveness in an actual classroom setting. The

knowledge and information obtained from these evaluation stages inform the next step: refining and developing the validated ethnomathematical lesson modules. This comprehensive approach, which involves moving from design to validation and refinement, ensures that the finished product remains educationally valid and a significant tool for integrating Mizo culture with mathematics education.

Findings related to objective 5:

Objective No.5: To study the effect of ethnomathematical teaching strategies on mathematics achievements among Class VIII students.

It is found that there exists a significant difference between the experimental and control groups with respect to the Test of Mathematics Achievement (TMA). The experimental group has a higher mean relative to the control group for the post-test results of students' mathematical achievement. Ethnomathematical teaching strategies have significantly enhanced students' mathematical achievement. The results of the Analysis of Covariance indicate significance that $F(1, 87) = 8.103$, and $p(0.006) < 0.05$.

Conclusion of the Study

Based on the findings of Objective 1, it can be concluded that several traditional materials from the Mizo culture exist and are used among community members. They are unique in their styles and methods of use within the Mizo culture. Based on the findings related to objective-2, it can be concluded that several mathematical concepts were integrated into the traditional activities of the Mizo culture, including tools, baskets, and pots. This indicates that if different mathematical concepts are integrated within a singular community, such as the Mizo, then in a nation like India, which has significant cultural and communal variety, similar investigations are necessary and can be conducted for improved generalizations Findings for objective 3 directed to conclude that the connotation of mathematical concepts at the Class VIII level with existing cultural mathematical elements of the Mizo tribe were identified. The connection between mathematics and existing cultural materials was considered satisfactory, and Mizo cultural materials can serve as examples, models, and demonstrations of mathematical concepts. The Mizo people unknowingly utilize mathematical skills in their daily lives, often unaware of their significance. The transfer of such skills to educational institutions is likely to help with instruction and comprehension of mathematics. Consequently, the skills of the people who

utilise mathematics within their cultures, although without formal training, may enhance the educational achievements of learners in the classroom. Based on the findings related to Objective 4, it is evident that the ethnomathematics lesson plan can be developed by using traditional Mizo cultural materials as learning tools or TLM in the classroom for Class VIII students. Based on findings related to objective 5, it has been concluded that ethnomathematical teaching strategies are effective in enhancing mathematics achievement among Class VIII students as compared to the conventional teaching method.

The National Curriculum Framework (NCF, 2005) advocates for developing children's mathematical skills and offers numerous recommendations to address challenges, including the necessity for children to comprehend the significance of mathematics in everyday life. This study also incorporates the same ideas and promotes the multicultural and ethnomathematical components of mathematics education within the Mizo community. The researcher researched teaching and learning mathematics through traditional practices of the Mizo culture. Likewise, numerous community and local organisations engage in cultural activities that may be beneficial for instructing mathematics and other related disciplines. Our nation possesses a variety of cultural and tribal communities. This is necessary for transferring these diversities and activities from society to the classroom and adapting them for educational purposes through study. By considering the students' shared experiences, individual learning styles, beliefs, and diversities, educators and the school environment can improve the teaching and learning of mathematics and other scientific disciplines.

Educational Implications of the Study

The results derived from the findings of this study suggest several educational implications for students, teachers, teacher educators, and curriculum developers. They are as follows:

- Mathematical elements that exist in the Mizo tribe can be utilised for the teaching and learning of mathematics, serving as teaching-learning materials for educators, students, and curriculum creators.

- The connotation of a mathematical concept with cultural elements can make students' perspectives more interesting.

- The developed lesson plan changes the dimension of mathematics, highlighting that it is applicable in real-life situations.

- Ethnomathematical teaching strategies may serve as an improved alternative to conventional methods for improving students' mathematics achievement.

- This study might assist in the design and implementation of a mathematics curriculum that incorporates cultural and traditional aspects, as supported by the NCF-2005 suggestion.

Limitations of the Study

The findings and conclusions of the present study were constrained by the following limitations, which should be considered before generalising the results:

- Data on demographic characteristics such as sex, age, locality, and socioeconomic status were obtained but were not included in the study.

- This study is subject to the normal limitations of quasi-experimental design (including non-random assignment); it is possible that the subjects in the two groups differed fundamentally in ways unknown to the experimenter. To address these discrepancies in the experiment, the analysis of covariance technique (ANCOVA) was employed to derive significant conclusions.

Suggestions for Further Research

Based on the experiences and findings of the current study, the researcher proposes the following suggestions for further research.

- The current study was confined only to the Mizo culture; similarly, it can be organized on other cultural, traditional, or tribal communities in India or abroad.

- The current study focused on the variable of ethnomathematics; likewise, it can be organised for ethno-physics, ethno-chemistry, and ethno-science for the same or diverse contexts.

- To investigate the impact of the ethnomathematics teaching strategies, similar research might be conducted with students from different educational boards, different classes, and demographic characteristics.

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