

STEM Education and Mathematics Performance among Orang Asli Primary School Students in Johor, Malaysia: Challenges and Recommendations

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Abstract— *This research paper addresses the complexity of improving STEM education and mathematics achievement of indigenous students, better known as Orang Asli, in primary schools in Johor, Malaysia. The study highlights the educational disparities of the Orang Asli community and emphasizes the need for culturally tailored and linguistically supportive interventions. The study uses a mixed-methods approach to analyze academic achievement data. Significant challenges that hinder Orang Asli students' abilities in Mathematics and STEM subjects are identified. The discussions show that strategies such as incorporating ethnomathematics - linking cultural knowledge to mathematical concepts, and code-switching in the classroom can effectively bridge the gap between students' cultural backgrounds and the academic curriculum. These recommendations are in line with the United Nations Sustainable Development Goals, which aim to ensure inclusive and equitable quality education for all. The article concludes with actionable policy suggestions that advocate for the integration of culturally sensitive teaching methods to improve the academic performance of Orang Asli students. The importance of community engagement and longitudinal studies in evaluating the effectiveness of such interventions is emphasized. The findings presented are intended to effect change in educational practices and create an inclusive learning environment for Orang Asli children and by extension, other indigenous populations worldwide - contributing to the overarching goal of educational equity. This study is in line with the aspirations of the Malaysian Education Plan and contributes to two Sustainable Development Goals (SDGs): SDG4 (Quality Education) and SDG10 (Reduce Inequalities).*

Keywords— Indigenous; Mathematics; STEM education

I. INTRODUCTION

STEM education is important to equip students with the skills they need for a successful career. Critical thinking, problem-solving and scientific literacy are crucial skills that can be developed through STEM education and will prove invaluable in the future [1]. STEM education is an educational approach that aims to enhance students' cognitive abilities and develop their skills to make them competitive and prepared for their preferred fields [2]. Malaysia strives to equip students with the necessary knowledge and skills in science, technology, engineering and mathematics to meet the challenges of the 21st century through STEM education. Teaching students these

foundational skills makes them better prepared to succeed in a rapidly changing world [3]. Mathematics, a fundamental component of STEM education, provides the essential building blocks for understanding other disciplines within STEM education [4]. Developing analytical and problem-solving skills through mastery of mathematical concepts is critical for success in science, technology, and engineering [5]. These students can improve their cognitive abilities, problem-solving skills, and overall academic performance by gaining a solid foundation in mathematics [6]. Furthermore, a focus on mathematics in STEM education can help these students bridge the gap between theoretical knowledge and practical application, making their learning more relevant and meaningful to their daily lives [2]. In the context of the Orang Asli, an indigenous community in Malaysia, there are significant challenges and opportunities in STEM education and mathematics performance. As these Orang Asli students often face unique socioeconomic and cultural barriers, it is important to understand how these factors influence their learning experiences and academic achievement in mathematics [7]. It is critical to understand the specific challenges of implementing STEM education, especially among indigenous communities such as the Orang Asli [8]. Despite efforts to promote STEM education, significant barriers still prevent effective learning success for these students [9]. Therefore, it is imperative to identify the specific challenges that Orang Asli students face in learning mathematics and provide tailored recommendations to overcome these issues.

II. THE EDUCATION OF ORANG ASLI IN MALAYSIA

The Orang Asli, the indigenous peoples of Malaysia, consist of 18 distinct ethnic groups that can be divided into three main categories: the Malay-Proto, Negrito, and Senoi [10]. Within the Malay-Proto category, the Jakun tribe is predominant in Johor alongside other groups such as the Temuan and the Orang Seletar. This study focuses on the Jakun, a tribe that maintains a close tie to the land through their traditional way of life. This way of life includes farming, river and coastal fishing, and harvesting forest products such as rattan and honey. Their cultural practices and economy are inextricably linked to the

land and reflect a long-standing tradition of preserving customary land rights and maintaining a symbiotic relationship with the natural world. The Orang Asli is considered the original inhabitants of Peninsular Malaysia, predating the arrival of the Malays. Their name, "Orang Asli," translates to "original people" or "first people" in Malay, reflecting their historical presence in the region. They comprise a diverse group with a wide range of languages, cultural practices, and spiritual beliefs. For centuries, they lived as hunter-gatherers and practiced shifting cultivation, maintaining a harmonious relationship with the natural environment.

Despite the richness of their cultural heritage, Orang Asli students have significant educational disparities compared to the national average. Only 61% of students at the National Indigenous School (SK Asli), which includes students from the Jakun community, pass the core subjects of the Primary School Achievement Test — a stark contrast to the national pass rate of 87% [11]. Structural barriers further impede the educational success of these students: many live in remote areas, resulting in limited access to pre-school education and lower levels of literacy and numeracy skills at the start of formal schooling [12]. Furthermore, the Malay language of the regular curriculum is not their first language, which is an additional barrier to their learning progress [13]. SK Asli Teachers also acknowledge a gap in their preparation. Current training programs do not provide them with the skills and knowledge they need to effectively manage the specific cultural and educational needs of Orang Asli students [14]. The confluence of these factors underscores the urgent need for targeted educational strategies tailored to the unique context of the Orang Asli.

To address the educational challenges of Orang Asli students, inclusion in STEM subjects must be promoted through culturally appropriate teaching methods [15]. Teachers can draw on the extensive indigenous knowledge of Orang Asli communities, such as the Jakun tribe's expertise in agriculture and ecology, to contextualize STEM lessons. By aligning scientific principles with the everyday experiences of Orang Asli students — for example, by combining lessons on sustainable agricultural practices with biology and environmental science, or introducing physical concepts through the mechanisms of traditional fishing — educators can make STEM subjects more engaging and relevant. This strategy of honoring students' cultural heritage in a scientific context not only engages their interest, but also honors their identity and promotes their ability to excel in STEM subjects [16]. It aims to give Orang Asli students an equal opportunity to succeed in science and in their future careers by creating a learning environment that is both meaningful and respectful of their traditions and knowledge.

The Malaysia Education Blueprint 2013-2025, launched by the Ministry of Education Malaysia, has identified eleven key shifts needed to transform the national education system. These include increasing investment in the physical and instructional resources available to students with special needs, such as those of the Orang Asli [17]. By 2025, these students should attend

schools equipped with the necessary facilities and resources to promote learning and be taught by teachers who have undergone specialized training to meet their special educational needs [18]. This comprehensive approach aims to close the academic gap and provide quality, relevant educational opportunities for all students [19]. To support this, the Ministry has put forward a specific action plan for the Orang Asli and other minority groups. This includes initiatives such as intensive literacy interventions for young students to catch up with early education, the establishment of research centers to develop curriculum and pedagogy tailored to minority groups, and professional development programs to prepare educators for the unique circumstances of Orang Asli schools [17]. These strategies aim to provide a solid foundation for Orang Asli students to succeed and contribute meaningfully to Malaysia's diverse society.

III. STUDIES ON MATHEMATICS EDUCATION FOR ORANG ASLI STUDENTS IN MALAYSIA

Research on mathematics education in Malaysian schools is limited, with most studies focusing on aspects of general education at primary and secondary levels. Recent studies focusing on mathematics education include the study by [20], who conducted a comparative study to examine the mathematics performance of Orang Asli students in Grade 5 using a test of 30 arithmetic problems and 20 mathematical problem problems in both Malay and the Orang Asli language, Temiar. The Temiar tribe is an Orang Asli ethnic group in Malaysia, mainly found in Perak, Pahang and Kelantan (northern and eastern coastal regions of Malaysia). The study by [21] aimed to determine the numeracy skills of Orang Asli students in elementary school and the relationship between their performance in written and oral examinations. To assess numeracy skills, 87 Orang Asli students in Johor participated in a written numeracy test, and their responses were analyzed using percentages. Ref [22] investigated the mathematics performance of Orang Asli students in a bilingual mathematics test. The two tests, which covered mathematical calculations and problems, included three main topics: Number Operations, Money and Time. Eight Orang Asli elementary schools in the district of Sungai Siput, Perak, with 230 Grade 5 (11 years old) students participated in this study. Ref [8] investigated the mathematics performance of Grade 6 students in Orang Asli schools. Their study also aimed to determine whether Orang Asli students' perceptions, interests and knowledge influenced their performance in mathematics. A total of 86 grade six Orang Asli students from five Orang Asli schools in Selangor participated in this study. From the perspective of mathematics teachers who teach Orang Asli students, [23] gathered teachers' views on the teaching and learning of mathematics in Orang Asli schools. This study investigated teachers' views on problems and challenges in teaching and learning mathematics to Orang Asli primary school students in Malaysia. It determined whether language plays a crucial role in teaching mathematics to Orang Asli students [24]. The research conducted by [18] has undoubtedly shed light on the challenges and achievements of Orang Asli students in the teaching of

mathematics at the primary school level. However, there is a noticeable gap in identifying and analyzing barriers that affect Orang Asli students' mathematical problem-solving abilities. The current studies have provided insights into the mathematics performance and language role in Orang Asli students' learning. However, further exploration is needed to understand the factors impacting their numeracy skills, especially in problem-solving. This research aims to explore the causes of Orang Asli students' difficulties in solving numerical and mathematical problems, helping to develop targeted strategies for improvement.

IV. THE NATIONAL SCHOOLS FOR INDIGENOUS PEOPLES (SK ASLI) IN JOHOR

The total of 10 National Schools for Orang Asli (SK Asli) in Johor are mainly located in rural areas and usually cater to some nearby Orang Asli villages. According to the Ministry of Education (MOE) Circular No. 2 of 2014 [25], three of these ten schools are considered rural – Sekolah Kebangsaan Punan, Sekolah Kebangsaan Peta and Sekolah Kebangsaan Kampung Kudong. Sekolah Kebangsaan Punan in Kluang and Sekolah Kebangsaan Peta in Mersing are classified as moderately challenging (P2) schools, while Sekolah Kebangsaan Kampung Kudong in Segamat is considered less challenging (P1). According to MOE Circular Letter 5 of 2014 [26], the classification of rural areas is based on factors such as transportation, availability of water and electricity and other facilities, with P3 being the most challenging. Due to the lack of road access, Sekolah Kebangsaan Punan, which is located in Kampung Punan along the Endau Water, had to rely on transportation via the river in the past. It can now be visited all year round by boat or canoe on the river. Most of the overland route is along unpaved agricultural and logging roads. Kahang in Kluang, the nearest town, is almost 45 kilometres away. Another notable rural SK Asli is SK Peta in Kampung Peta, the most inland outpost of the Jakun people in Johor. About 60 kilometres from the main Kahang-Mersing Road, this place is located between Mount Janing and Bukit Peta. Four-wheeled vehicles are required to reach Kampung Peta. The third rural SK Asli is SK Kampung Kudong in Bekok, Segamat. It is a school that provides education to six different Orang Asli villages. Although Kampung Kudong is still considered rural, a road was recently built there to improve accessibility. Previously, the route consisted of dirt roads for logging and farming. The difficult geographical location of the Orang Asli National Schools in Johor poses a significant barrier to students' access to quality education.

V. METHODOLOGY OF THE STUDY

This study uses a mixed methods approach to investigate the relationships between STEM and math achievement among Orang Asli primary school children in Johor, Malaysia. By diagnosing the mathematical challenges and the broader spectrum of STEM education faced by these students, this study aims to suggest strategic interventions for an enhanced learning experience.

A. Quantitative Component

A customized math test was developed to assess the foundational skills required in STEM fields, such as number sense and problem-solving skills that focus on whole numbers and basic operations, to measure STEM readiness. The use of a customized mathematics assessment test in this research is justified as it allows for the direct measurement of specific foundational STEM skills, providing quantifiable data for evaluating STEM readiness among students [27]. Three math education experts reviewed the test content to ensure its relevance and integrity. The test consists of two components. The numerical part consists of ten consecutive questions, each worth one mark and worth a total of ten points, consisting of questions like arranging numbers in ascending and descending orders, rounding up numbers, and solving direct basic operation questions. The problem-solving portion includes five questions that apply arithmetic operations to realistic situations typical of STEM applications and is worth twenty points. For instance, a question might describe a scenario involving an experiment where basic operations like addition and subtraction are included in calculating the total amount of the ingredients needed for the experiment. The test was administered to a sample of 142 Orang Asli in Grades 4 and 5 from 10 National Indigenous Schools (SK Asli) in Johor. This structured assessment aims to quantitatively assess students' abilities in mathematical concepts that underpin STEM learning and their potential for practical problem-solving in STEM-related contexts.

B. Qualitative Component

The qualitative aspect of the study involves conducting semi-structured interviews with 13 math teachers from SK Asli and three experts in indigenous education. The interviews are designed to explore pedagogical approaches and assessment techniques for Orang Asli students. To gain authentic insights, all interviews were systematically recorded and transcribed verbatim [28]. The qualitative data analysis will provide a deeper understanding of the challenges faced by Orang Asli students in mathematics classrooms and the strategies used by teachers. This mixed methods research aims to analytically assess and qualitatively understand Orang Asli students' math skills in STEM contexts. This research seeks to identify the academic and contextual factors that influence these students' math achievement through the use of carefully designed assessments and in-depth interviews. Qualitative feedback from teachers and Indigenous education experts will provide nuanced insights into day-to-day educational dynamics and complement the objective results of quantitative testing. This concerted effort aims to identify actionable educational interventions that are both pedagogically sound and culturally responsive.

VI. DATA ANALYSIS

A. Quantitative Analysis

The study utilized quantitative methods to gather data on the mathematical performance of Orang Asli elementary school

students. Standardized mathematics tests were administered to collect meaningful data on students' numerical calculation and mathematical problem-solving skills. This data collection was crucial for establishing a baseline of their academic skills and identifying specific areas of concern. The utilization of error analysis methodology has been proven crucial in the quantitative study of assessments [29]. Through this approach, researchers have been able to establish a comprehensive framework for the exploration of the various types and patterns of errors made by students [30]. It is widely recognized that error analysis is based on the understanding that errors serve as indicators of underlying misconceptions or knowledge gaps rather than mere accidental inaccuracies [31]. By conducting an in-depth analysis of these errors, researchers have gained invaluable insights into students' cognitive processes and the challenges they encounter in the instructional environment [32]. As a result, several significant findings have emerged from the meticulous data analysis undertaken.

TABLE I ORANG ASLI STUDENTS' MARKS IN NUMERICAL AND WORD PROBLEM QUESTIONS ACCORDING TO SCHOOLS

SK Asli	Numerical Problem	Word Problem
SK Asli Peta	64	8
SK Asli Punan	68	38
SK Asli Seri Sedohok	164	60
SK Asli Labong	100	16
SK Asli Sayong Pinang	76	18
SK Asli Kg Layau	61	20
SK Asli Segamat Kecil	62	20
SK Asli Pengkalan Tereh	96	42
SK Asli Tanah Abang	122	18
SK Asli Kg Kudong	65	8

Table I displays students' scores for numerical and word problem questions, with the marks representing the overall performance of all students in the school. Orang Asli students consistently demonstrate stronger performance in numerical mathematics compared to mathematical problem-solving questions across all schools.

TABLE II NUMBER OF STUDENTS BY TYPE OF CHALLENGES

	Question 1							Question 2							Question 3							Question 4							Question 5										
	Δ	O	#	Ψ	α	β	\surd	Δ	O	#	Ψ	α	β	\surd	Δ	O	#	Ψ	α	β	\surd	Δ	O	#	Ψ	α	β	\surd	Δ	O	#	Ψ	α	β	\surd				
A	5	2	1	2	0	1	0	4	2	1	2	0	0	2	3	2	1	1	0	2	2	5	2	4	0	0	0	0	7	2	2	0	0	0	0				
B	5	2	0	0	0	0	4	3	2	0	0	0	0	6	2	2	2	0	0	1	4	4	2	1	0	0	1	3	5	2	2	0	0	0	2				
C	7	3	2	0	1	0	0	3	3	4	0	2	8	3	5	3	5	0	1	3	6	5	3	9	0	2	0	4	7	3	1	0	0	0	2				
D	1	2	5	0	1	0	3	3	2	5	0	0	0	2	3	2	6	0	0	0	1	2	2	6	0	1	0	1	1	2	7	0	1	0	1				
E	9	5	1	0	0	4	1	1	5	2	0	1	6	5	1	5	6	0	0	5	3	4	5	9	0	2	0	0	1	5	4	0	0	0	0				
F	4	1	2	0	0	0	3	3	1	4	0	0	0	2	3	1	4	0	0	0	2	0	1	4	0	0	3	2	3	1	4	0	0	1	1				
G	1	1	4	0	0	1	3	3	1	4	0	0	0	2	3	1	4	0	0	0	2	1	1	5	0	0	1	2	1	1	7	0	0	0	1				
H	7	0	1	0	1	2	6	4	0	3	0	0	4	6	6	0	3	0	0	4	4	1	0	8	0	1	4	3	5	0	0	0	0	2					
I	2	2	6	0	1	0	5	2	2	8	0	0	1	3	2	2	1	0	1	0	1	2	2	1	0	0	0	0	2	3	0	0	1	0					
J	5	2	3	0	1	1	0	1	2	3	0	2	1	3	1	2	6	0	1	1	1	5	2	4	0	1	0	0	2	2	7	0	1	0	0				
	4	2	25	2	5	9	3	2	2	3	2	5	2	3	2	2	4	1	3	1	2	2	2	6	0	7	9	1	3	2	7	0	2	2	9				
	6	0				5	7	7	0	4		0	4	9	0	7			6	6	9	0	2				5	2	0	7									
Tot al	142							142							142							142							142										
Legend:								Δ : Misconceptions																															
A: SK Asli Peta								O: Unable to read																															
B: SK Asli Punan								#: Failure to understand the question																															
C: SK Asli Seri Sedohok								Ψ : Lack of comprehension of specific terms contained in the question																															
D: SK Asli Labong								α : Did not complete the solution steps																															
E: SK Asli Sayong Pinang								β : Carelessness or mistakes while solving problems																															
F: SK Asli Kg Layau								\surd : Correct																															
G: SK Asli Segamat Kecil																																							
H: SK Asli Pengkalan Tereh																																							
I: SK Asli Tanah Abang																																							
J: SK Asli Kg Kudong																																							

Table II provides a detailed breakdown of the student's math problem-solving tasks. Table II presents the breakdown of the number of students encountering challenges in each question by type of challenge. Following an extensive error analysis, it was established that students faced various issues, including (i) failure to comprehend the question, (ii) misconceptions, (iii) lack of understanding of specific concepts within the question, (iv) carelessness or errors in problem-solving, (v) failure to complete the solution steps, and (vi) inability to read. The predominant challenges identified were misconceptions, inability to read, and failure to understand the question. It is imperative to promptly address the challenge of the inability to read among Orang Asli primary school students in Malaysia. For the first question, 46 (32.4%) out of 142 students had misconceptions, 14.1% could not read and 17.6% did not understand the question. For the second question, 23.9% were unable to understand the question and 19% had misconceptions. For the third question, 33.1% did not understand the question and 20.4% had misconceptions. Many students also did not understand questions 4 and 5, namely 43.7% and 54.2% respectively. The table above also shows that the number of students who answered questions 1, 2 and 3 correctly is higher than for questions 4 and 5. The first three questions are about addition and subtraction operations, while the last two are about multiplication and division operations. The percentage of students who answered the questions correctly was 24.6% for question 1, 23.9% for question 2, 18.3% for question 3, 10.6% for question 4 and 6.3% for question 5. This indicates that Orang Asli students are more proficient in these two basic arithmetic operations than multiplication and division, which seem to be more difficult.

B. Qualitative Analysis

Building upon the earlier quantitative analysis, the study utilized a qualitative approach to delve deeper into Orang Asli students' multifaceted educational challenges. Delving beyond the numbers, the research involved in-depth interviews with math teachers and Orang Asli education experts to gain a more comprehensive understanding that could not be derived from numerical data alone. The study aimed to gain comprehensive insights and produce rich and nuanced results by employing a mixed methods approach that combines quantitative and qualitative research. In the realm of mixed methods research, scholars such as John W. Creswell have significantly contributed to the understanding and development of this approach, as noted in ref [33]. The interviews, which were conducted by two researchers, were meticulously audio-recorded to preserve accuracy and ensure the fidelity of the information gathered. Participants were asked to provide their perspectives on the most effective assessment methods tailored to the unique educational needs of Orang Asli students. Thematic analysis, following the established guidelines of Braun and Clarke as indicated by ref [34], was methodically applied to examine the assessment methods used in mathematics education for Orang Asli students. This in-depth analysis yielded two prominent themes: culture-based assessment and environment-based assessment, shedding a spotlight on the nuanced considerations and tailored approaches necessary for

effective educational assessment within this specific cultural context.

The first theme identified is the assessment method based on the Orang Asli students' environment. One of the interviewees stated:

"If we only change the content of the questions based on the environment of Orang Asli students, without changing the concept or value and without lowering the level of the assessment questions (for example) when we talk about fruits, they might know various types of fruits, but if we ask about types of cars, they might find it difficult to relate to their daily lives. If we make such changes, I would agree. Processing questions in a context close to the Orang Asli students might help."

Another respondent stated that changing the form of questions to those related to the Indigenous students' environment can help students achieve a better level of mathematical performance:

"If we change the question to one that relates to them and use an environment close to them, for me, it will help. So, they can apply that thing. It means they understand that thing. Maybe it's difficult for them to understand if it's beyond their knowledge."

One of the interviewees also provided an example of the use of assessment methods based on the Orang Asli student environment by stating:

"For example, if the assessment is to create a portfolio, we can ask them to create based on their environment and daily life practices. The rubric in the assessment should refer to what they experience every day. We need to consider the environment and the way of life of the Orang Asli community, which is different from the outside community."

The second theme identified is the form of valuation based on the culture of the Orang Asli community. The respondents felt that the existing assessment methods do not need to be changed when designing the mathematics framework curriculum for Orang Asli students. Nevertheless, the examples used in the students' assessments should be related to the Indigenous students' socio-cultural aspects so that the students understand the questions better. This is illustrated by one respondent who stated:

"For me, the assessment does not need to use different concepts; it just needs to use the existing curriculum. Only the questions are different. The form of the solution or answer is the same. Only the statement of the question is different."

The statement by another respondent that a mix of socio-cultural elements of Orang Asli students should be included in the assessment questions is also essential:

"It's also a good idea to include Indigenous elements, but not 100 percent. We also need to include external elements. For example, there is nothing about them now (Orang Asli in the syllabus). The questions are only related to modern emphasised matters."

VII. DISCUSSION

The quantitative and qualitative analyses shed light on the challenges faced by Orang Asli students in mathematics classes and provided valuable insights into possible interventions to improve their mathematical skills. The quantitative analysis highlighted the differences in performance between the different types of math problems and highlighted the need for targeted interventions to address the particular challenges faced by Orang Asli students. In addition, the qualitative analysis highlighted the importance of culturally relevant examples and contexts in the mathematics curriculum to improve student engagement and understanding. It also emphasized the importance of language support and strategies to bridge the gap between the student's linguistic background and the language of mathematics instruction. The results of both analyses point to the need for holistic interventions that address the academic aspects of learning and the cultural, linguistic, and emotional factors that influence students' math skills. It is evident that a one-size-fits-all approach is not appropriate for Orang Asli students and that tailored interventions are necessary to create a more inclusive and effective learning environment that addresses their unique needs and challenges.

A. Why do Orang Asli Students Perform Better in Numerical Questions Than Problem-Solving Questions?

The disparity in academic performance among Orang Asli students, where proficiency in numerical tasks contrasts with difficulties in problem-solving questions, presents a significant area for inquiry. Numerical tasks often necessitate the direct application of learned procedures, and current teaching methods emphasizing rote memorization and repeated practice appear to support this proficiency [35]. This observation aligns with students' competencies in tasks such as arithmetic, which allow for sequential methods in arriving at solutions [36]. Conversely, problem-solving tasks embed mathematics in broader contexts, demanding abstract and critical thinking skills [37]. These cognitive abilities may remain underdeveloped if current pedagogical approaches fail to actively nurture them through encouraging higher-order analysis and application of learned concepts [38]. Compounding the aforementioned challenges, problem-solving tasks typically incorporate complex language to describe real-world scenarios, presenting additional difficulties, particularly when the language of instruction diverges from the student's first language, hindering their comprehension and adaptation of textual information into a mathematical framework [39].

It is imperative for the education system to adapt in order to enhance problem-solving proficiencies among students [40]. Likely adaptations could involve integrating real-life, relatable problem scenarios, particularly those reflecting instances within students' daily lives or cultural practices, thereby bridging cultural disparities and furnishing students with a foundation for applying numeracy skills across various contexts. Additionally, transparent communication and the implementation of bilingual teaching strategies, where feasible, may effectively address language barriers [41]. Addressing the achievement gap of Orang Asli students in problem-solving versus numerical competencies is a pivotal

endeavour. Doing so is instrumental in endowing these students with a well-rounded mathematical toolkit suited to the demands of their academic pursuits and cultural milieu. This approach not only augments academic achievement but also fosters an inclusive and empowering environment within the educational landscape.

B. Culturally Responsive Assessment in Mathematics and STEM Education for Orang Asli Students

A culturally sensitive assessment goes beyond merely optimising existing assessments; it represents a fundamental shift in measuring student learning, acknowledging and leveraging their cultural strengths [42]. Its role in math and STEM education is especially critical for accurately evaluating the abilities of Orang Asli students. In order to support the unique learning needs of these students, it is imperative to adapt assessment methods that consider their cultural identity and linguistic background when gauging academic progress in these subjects [43]. These assessments should transcend traditional, standardized formats to encompass more dynamic, contextualized evaluations that resonate with students' experiences [44]. For instance, integrating elements of the local environment and community practices into math and science tasks can validate students' cultural knowledge and foster a more authentic engagement with the content [45]. In the realm of mathematics, this approach could involve using culturally relevant examples and scenarios to teach concepts such as geometry, measurement, and algebra, drawing from traditional architecture or Orang Asli crafts. Additionally, incorporating the native language of Indigenous students in STEM exams can alleviate cognitive load, allowing them to concentrate on demonstrating their comprehension of complex concepts without the added burden of language translation. Furthermore, the utilization of project-based learning and assessments in STEM lessons encourages Orang Asli students to leverage their inherent problem-solving skills and collaborate on real-world challenges [46]. This hands-on approach is congruent with the pragmatic nature of STEM subjects and can effectively demonstrate students' competencies in applying their knowledge to relevant scenarios [47]. The implementation of culturally sensitive assessment strategies in mathematics and STEM subjects is not just about equity; it is also about empowering Orang Asli students to recognize the value and application of their learning within their cultural context [48]. By reflecting on their life experiences in the assessments, educators can gauge what truly matters in student learning and offer a more comprehensive understanding of each student's academic potential [49].

C. Enhancing Orang Asli Students' Mathematical Problem-Solving Through Ethnomathematics

Ethnomathematics offers a holistic and culturally responsive approach to promoting mathematical problem-solving skills in Orang Asli students by integrating their cultural context into mathematics instruction [50]. This pedagogical strategy deepens students' understanding and appreciation of mathematics by emphasizing its relevance to their indigenous knowledge and everyday experiences [51]. By incorporating ethnomathematics into the curriculum, educators can design

content that reflects the cultural practices of the Orang Asli, thus creating a more meaningful learning experience for the students. Mathematical concepts and problem-solving exercises can be derived from traditional activities such as navigation, agriculture, and handicrafts [52], where Orang Asli communities have utilized practical mathematics for generations. One of ethnomathematics' key benefits is its ability to connect familiar cultural practices with abstract mathematical concepts, allowing students to transfer their problem-solving skills to unfamiliar mathematical challenges [53]. This method provides a natural transition from recognizing patterns and performing calculations in a cultural context to applying these skills to broader mathematical and STEM-related concepts. By drawing on cultural reference points, educators can create learning experiences that resonate with the students' identity, thus enhancing their ability to engage with and understand mathematical concepts more deeply.

Moreover, ethnomathematics is not only an element of culturally sensitive education but also an influential tool that uniquely addresses the intersection of culture and mathematical cognition. This approach specifically enhances Orang Asli students' abilities to analyze and solve problems effectively, contributing to a richer, more comprehensible, and ultimately more successful math learning experience. By exploring symmetries and patterns in cultural artefacts, such as traditional crafts and Indigenous designs, students can enhance their spatial reasoning and geometric skills, leading to improved problem-solving abilities. This approach ensures that the indigenous knowledge and experiences of the Orang Asli are integrated into the learning process, promoting a sense of cultural identity and pride while developing essential mathematical competencies. Ethnomathematics provides an effective and empowering framework for mathematics education among the Orang Asli. It bridges cultural heritage and academic learning, offering a pathway to a more comprehensive and successful math learning experience. It is critical to cultivate an educational environment that resonates with the identity of Orang Asli students. Incorporating ethnomathematics into the education system can have a transformative impact, enabling students to develop a deeper understanding of mathematics within the context of their own culture and experiences.

D. Utilizing Code-Switching to Enhance Mathematics and STEM Learning for Orang Asli Students

Code-switching, the methodical switching between languages in the educational environment, is crucial for teaching STEM and mathematics to Orang Asli students [54]. It is a linguistic strategy that, when used thoughtfully, has the potential to not only overcome language barriers but also create pathways for deeper understanding and engagement in STEM subjects [55]. Educators who use code-switching in math classrooms provide Native students with a bilingual scaffold that bridges their native language and the academic language of math and science [56]. This strategy respects and capitalizes on linguistic diversity in the classroom and allows teachers to explain complex concepts in a more accessible way — first in the students' familiar language and then in the official language of instruction [57]. This transition from familiar linguistic constructs to new terminology is crucial for

building cognitive connections in STEM subjects. By repeating and reinforcing math and science concepts in students' native language, teachers are better able to assess understanding and correct misconceptions. This inclusive approach is consistent with discussions of culturally responsive education and ensures that content is delivered in a way that is cognitively accessible to all students, regardless of their native language. Echoing previous discussions of ethnomathematics and culturally sensitive assessment, code-switching is an essential component of an overarching strategy to improve Orang Asli student achievement in STEM fields. It is a communication and educational tool that complements other recommendations to improve learning. Therefore, code-switching in mathematics and STEM classrooms is an adaptable and nuanced approach to teaching Orang Asli students. It is one of the many strategies that when combined with culturally sensitive curriculum and assessment methods, create a harmonized educational experience that is tailored to the needs of Orang Asli students and helps to narrow the achievement gap in these important areas [56].

VIII. CONTRIBUTIONS OF THIS STUDY

This research significantly contributes to the field of indigenous education by addressing the educational challenges encountered by Orang Asli students in Malaysia, particularly in STEM and mathematics. It underscores the need for targeted interventions to bridge the achievement gap and advocates for culturally responsive pedagogies to create an inclusive learning environment. The study aligns these strategies with broader educational goals, emphasizing the importance of educational equity in fostering an equitable society for all Malaysian children. Additionally, it underscores the significance of evidence-based and culturally sensitive educational policies and practices through ongoing research and community engagement.

IX. CONCLUSION

Addressing the educational needs of Orang Asli primary school students, particularly in STEM and mathematics, presents a crucial opportunity for recognizing challenges and proposing necessary improvements. This study has revealed significant disparities in mathematics achievement, underscoring the pressing need for culturally responsive and linguistically supportive interventions. Strategies such as ethnomathematics and code-switching have been identified as imperative for establishing a learning environment that resonates with the experiences of Orang Asli students. By integrating cultural relevance into mathematics instruction and incorporating Indigenous languages into classroom discourse, educators can provide these students with a deeper understanding and appreciation of STEM disciplines. Furthermore, these strategies align with broader educational goals, such as the United Nations Sustainable Development Goals. Ensuring quality education and reducing inequalities, as outlined in SDGs 4 and 10, are vital within the context of Orang Asli students, who have historically faced educational marginalization. Expanding on the insights and discussions in this article, it is recommended that educational policies and practices for Orang Asli students be adapted to incorporate culturally responsive teaching methods. This should be

accompanied by ongoing research to evaluate the effectiveness of such methods and continued collaboration with the communities they aim to serve. Ultimately, improving STEM education and mathematics skills for Orang Asli students necessitates concerted action from various stakeholders. By implementing evidence-based, culturally-informed educational practices and policies, we can positively impact Orang Asli students and enhance the Malaysian education system, thereby creating a more equitable and progressive educational landscape for all Malaysian children. It is important to acknowledge the limitations of this study. The research was region-specific and may not be universally applicable to all Orang Asli communities in Malaysia. Further research is required to explore the nuances and diverse experiences of Orang Asli students across different states and cultural groups. Additionally, while this study focused solely on primary school education, there is a need for further investigation to comprehend the challenges and opportunities at the secondary and tertiary levels

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