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Article

Integrating Indigenous Knowledge Systems into Advanced Mathematical Formula Development: A Framework for Curriculum Innovation in Southern Africa"

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Abstract: This doctoral research takes a step further to explore how IKS could be deployed to enhance the creation of even more complex formulas for advanced mathematics curricula, thereby providing a sound framework for curriculum enhancement in Southern Africa. It aims at bridging gaps of what Indigenous mathematics has yet to be allowed to contribute to modern mathematics education and higher education development. We use case studies, ethnomathematics, post-colonial education theory, and curriculum development models as discourses in this research to explore how IKS may potentially recast the rephoneticised formulation of mathematical equations in line with the socio-cultural realities of southern Africa.For this reason, the proposed framework revolves around three key elements. First, it supports conceptualizing and cataloguing Indigenous knowledge in mathematics and their rough appreciation as knowledge systems emanating from Indigenous peoples. Second, it focuses on integrating these ideas into current mathematical contexts—within the current storyline of mathematics, integration between traditional and innovative mathematical approaches. Last, it captures the re-contextualization of educational content in collaboration with Indigenous people, scholars, educators, and policymakers for relevance, equity, and practicality.This work also explores the issues involved in implementing IKS in formal education, where resources are scarce; Indigenous knowledge and skills are not valued; culture and timely entry are issues that are not given adequate attention, and there is a critical need to prepare teachers through other professional development programmes to enable them to provide for inclusive education. It outlines an approach to addressing these concerns, including creating culturally appropriate knowledge-sharing Radicals, co-designing curriculum with communities, and pursuing policies of equity.The research states that integrating IKS in formula derivation can redefine education through increased students' participation, enhanced diversity learning, and ultimately advocating Indigenous cultures. Moreover, it situates this integration as an enabler of future-oriented Implications, a new way of thinking mathematically for solving global problems using the architecture of both old and new knowledge systems.In conclusion, this work aims to enable the sharing of knowledge between indigenous and formal education systems towards prescribing radical changes to curriculum in Southern Africa. It imagines a future in which mathematical education not only represents but also appreciates various forms of knowledge in the region aenhancing the learning climates suitable for the global community. This work forms a platform on which postgraduate scholars, educators and policymakers can collectively reimagine and reposition Indigenous knowledge within advanced mathematical learning and academic pursuit.

Keywords: IKSM, Continuing The Work Of Formulating And Applying Mathematical And Other Useful Formulas, Curriculum Development, Southern Africa.

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1. Introduction

Mathematics is often perceived as a universal discipline, yet its development and application have been deeply influenced by cultural, historical, and regional contexts. In Southern Africa, as in many parts of the world, indigenous knowledge systems (IKS) have historically played a significant role in shaping mathematical thought and practices. However, colonial educational systems often marginalized these systems, leading to a lack of representation in formal curricula . This study aims to bridge the gap between traditional knowledge and contemporary mathematics by exploring how IKS can inform the development of advanced mathematical formulas and contribute to culturally inclusive curriculum innovation in Southern Africa.

Indigenous knowledge systems encompass a wide range of local practices, techniques, and wisdom accumulated over generations . In the mathematical domain, these systems include indigenous counting methods, geometric patterns, and spatial reasoning, which have historically been applied in activities such as architecture, navigation, and agriculture . Despite their potential value, these contributions are often excluded from mainstream education, which predominantly adopts Western-centric mathematical frameworks . This exclusion not only limits the richness of mathematical knowledge but also alienates students who might find greater resonance with mathematical concepts rooted in their own cultural contexts

Mathematics is often seen as originating from the basic needs of ancient societies, such as counting, measuring land, and tracking time. The earliest evidence of mathematical activity dates back to around 3000 BCE in ancient Mesopotamia, where the Sumerians and Babylonians developed systems of arithmetic and geometry. According to Burton (2011), early mathematics was primarily concerned with practical tasks like accounting, agricultural measurement, and astronomy.

Mathematics in Ancient Egypt and Greece: In Ancient Egypt, the practice of mathematics was also applied to tasks such as building pyramids and managing resources. The Egyptians were among the first to use a system of geometry for land surveying .The Greeks, particularly through figures like Euclid, Pythagoras, and Archimedes, transformed mathematics from a practical tool to an abstract discipline. Euclid's "Elements" (circa 300 BCE), a foundational text in geometry, laid the groundwork for deductive reasoning in mathematics. The Greek approach to mathematics was marked by a systematic organization of mathematical knowledge through axioms and proofs .

Islamic Golden Age Contributions: The Islamic Golden Age (8th–14th centuries) played a pivotal role in preserving and expanding mathematical knowledge. Scholars like Al-Khwarizmi made major contributions to algebra, and his book "Al-Kitab al-Mukhtasar fi Hisab al-Jabr wal-Muqabala" introduced systematic methods for solving linear and quadratic equations. This work laid the foundations for modern algebra and influenced European mathematics during the Renaissance .

Mathematics in the Modern Era: The development of modern mathematics took a significant leap with the advent of calculus, independently discovered by Isaac Newton and Gottfried Wilhelm Leibniz in the late 17th century. Their work is often credited with shaping the course of modern mathematics. The invention of calculus marked a pivotal moment in the history of mathematics, as it allowed for the study of continuous change, setting the stage for later developments in physics, engineering, and economics .

Recent advancements in ethnomathematics, the study of the relationship between mathematics and culture, provide a foundation for integrating IKS into formal education. Highlights the importance of contextualizing mathematical education to reflect local knowledge systems, arguing that such approaches enhance student engagement and foster critical thinking. This study builds on these principles by proposing a framework for incorporating IKS into the design of advanced mathematical formulas, with a focus on curriculum innovation.

The framework addresses three key areas: documenting indigenous mathematical concepts, aligning these concepts with existing mathematical frameworks, and developing collaborative educational materials involving indigenous communities, educators, and policymakers. By situating mathematical education within local contexts, this approach not only enriches the discipline but also serves broader goals of decolonization and sustainable development .

In this study, we examine the potential of IKS to inspire innovative approaches to mathematical formula development in Southern Africa, addressing challenges such as cultural sensitivity, resource constraints, and capacity building for educators. Through this exploration, we aim to contribute to the ongoing dialogue on decolonizing education and creating curricula that are both globally competitive and locally relevant.

Literature Review

Incorporating Indigenous Knowledge Systems(IKS) into curricula of modern education systems has also come into focus, especially when education systems are looking for suitable ways of diversifying their systems to de-colonies the limited Westernized global informative systems. Due to diverse traditional practices and beliefs among various groups of indigenous people of Southern Africa, a lot of potential exists as far as provable indigenous knowledge leading to the formulation of better mathematical equations is concerned. This integration can enhance the curriculum, make mathematics more relevant, and be close to the students and society. This literature review examines the theoretical practices of integrating IKS into advancing mathematics curricula in Southern African countries.

Indigenous Knowledge Systems in Mathematics

IKS is a specialized form of cultural heritage knowledge, discipline, and wisdom encompassing a community's practices and beliefs, often conventional, repetitive, and traditional. These systems entail a worldview that integrates knowledge with physical and cultural context and responds to the needs of the local context . IKS, therefore, is not only about who and how it provides solutions to peoples' immediate problems but also about a whole paradigm with epistemology and ontology for understanding and interacting with the physical environment. In mathematics, indigenous knowledge systems harbour considerable resources that can enrich and complement formal education on geometry, measurement, patterns and space relationships .

From the same sector of mathematics, the indigenous knowledge of mathematics is always expressed in the paradigms of daily experiences, and it possesses and captures the mathematical knowledge in natural form, which is still a confirmation of the professional mathematical thoughts that are contrary to the total formal education and artificialities that belongs to the western set of knowledge. In his opinion , continues that these Indigenous methods, as conveyed by Indigenous communities, are not mere fables or real-life examples but systematic approaches Indigenous communities use to reason mathematically. For example, counting methods that have been in use in different African communities, for instance, the Shona of Zimbabwe or the Zulu of South Africa, are complex and far from the methods of linear counting but include other aspects such as grouping and modular arithmetic . These counting systems embody number and operation schemata that can extend what students learn formally in mathematics classrooms by presenting other ways of counting.

Besides, counting systems comprise Indigenous mathematical knowledge: geometric architecture, land measurement and Indigenous navigation. For instance, elements such as geometric design and orientation related to African construction are critical in establishing appropriate and attractive structures and have always been the focus of traditional African architecture. Which, captures how geometric shapes have been used in the construction of huts and ceremony areas in Southern Africa; there was defined knowledge of symmetry and proportion in the construction of structures apart from

aesthetics of shapes . These architectural practices illustrate how geometry can be taught using real-life practices, thus facilitating students' teaching of geometrical concepts such as symmetry, area, and volume.

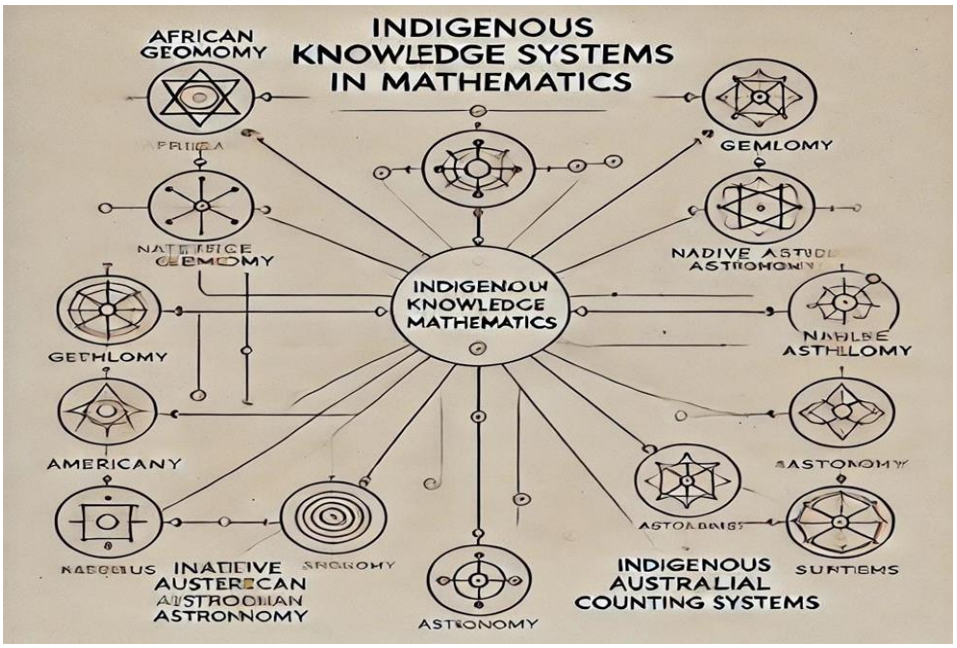
Also, astronomical knowledge embedded in the indigenous cycles provides mathematically rich content. Astronomical phenomena have been known for centuries by many indigenous peoples to plan their planting, navigation and calendars. For example, the indigenous people of Southern Africa, San, have learned to use the position of the stars and seasons to calibrate their agricultural activities . Comprehension of phases of the moon and positions of stars was applied in practical endeavors and in ways of the timely division of social activities. That kind of knowledge has a realistic foundation that can be used to demonstrate complicated topics such as trigonometry, angles, and periodic functions.

Incorporating such indigenous practices into the formal school system offers a good opportunity to supplement the arguably superior compilation of advanced mathematical student knowledge. Using IKS in the curriculum can always come with different approaches to solving mathematic issues and enhancing learners' creation and critical minds . As much as it helps the students identify with their own cultural knowledge systems that are harnessed when teaching mathematics, they get motivated to learn the content. In addition, this integration enhances Students' understanding of Mathematics because they can apply the knowledge they are learning in the classroom to their reality/point of view.

Integrating IKS into Mathematics syllabi can also assist in closing the gap between Mathematics and students' reality. For instance, counting patterns familiar to Indigenous people can replace number theory, or explaining symmetry with African art geometric design can make it more real to students. This approach also improves students' knowledge of mathematics and values Indigenous people's knowledge as an important and diverse part of intellectual production.

This is particularly the case in Southern Africa, where colonial and post-colonial education have influenced education; therefore, using IKS to teach mathematics is also a mechanism of decolonizing education. Most academics assert that education decolonization is the process of recapturing education by questioning how knowledge is constructed, disseminated, and accredited. When incorporating indigenous knowledge into education, the teacher not only undermines the monopoly of the Western systems of mathematics but also helps students see that we can indeed count on the indigenous way. This shift helps indigenous students and enhances the understanding of mathematics education as a multicultural topic .

Therefore, more research concerning including IK in advanced mathematics curricula in Southern African countries remains a rich potential for creating meaningful mathematical education. Even counting systems, geometry, and astronomical knowledge, which are part of Indigenous practices, can be implemented into the learning-teaching process to offer students a much richer and culturally diverse view of mathematics. Besides promoting growth in students' math, this approach supports the growth of critical thinking, innovation, and cultural engagement, thus enabling a more non-sexist and de-imperialized education system.



Curriculum Innovation in Southern Africa

Curriculum development in Southern Africa has indeed turned into a subject of interest in teaching reforms in the past few years, where more emphasis is placed on the reformulation of the historical impacts of colonialism and apartheid. The history of such socio-political systems produced imprints on education, especially in how curricula were developed and practiced. The call for curriculum development, especially after the decolonization process, aims to provide a watermark to the traditional imperialism-oriented Western perspectives on education. Consequently, scholars and educators in the region have called for adopting and implementing IKS in school curricula to extend education for everybody, ethnocentric and multicultural, so as to be sensitive to the diversity of learners.

Integrating IKS into the curriculum is part of a more extensive DE colonial course that seeks to unite educational systems with communities of color and their cultural and social histories. , Such curriculum innovation produces one of its primary objectives of narrowing the gap between the knowledge taught in school and young people's knowledge and experiences . IKS enables the curriculum developer to design meaningful instructional material for students as it blends with their daily experiences. The link between formal education and indigenous knowledge can improve how students embrace their cultural value system while enabling them to adapt to the prevailing world.

In the advanced level of mathematics curriculum, when learning becomes more concrete and specialized, incorporating IKS provides an enriched curriculum development area. Thus, mathematics education, frequently viewed as a formal and timeless science, could be enriched with native numerical and geometrical knowledge and skills, theories, and problem-solving skills developed over generations among people of various African tribes. This approach also reacts against mathematics as a prerogative of, let alone as a creation of, the Western world only. It establishes the view of mathematics as something constructed within cultural and historical settings. In this way, the students can increase their knowledge of mathematics and thereby obtain a global conception integrated with the local worldview.

It has also been notice that there is a need for curriculum reforms that integrate modem mathematics with African mathematical knowledge . They claim that a good curriculum can indicate the development of mathematical theory on the international level and consider the local mathematical practices and knowing practices that were muted in mainstream education. For example, there are mathematical and problem-solving

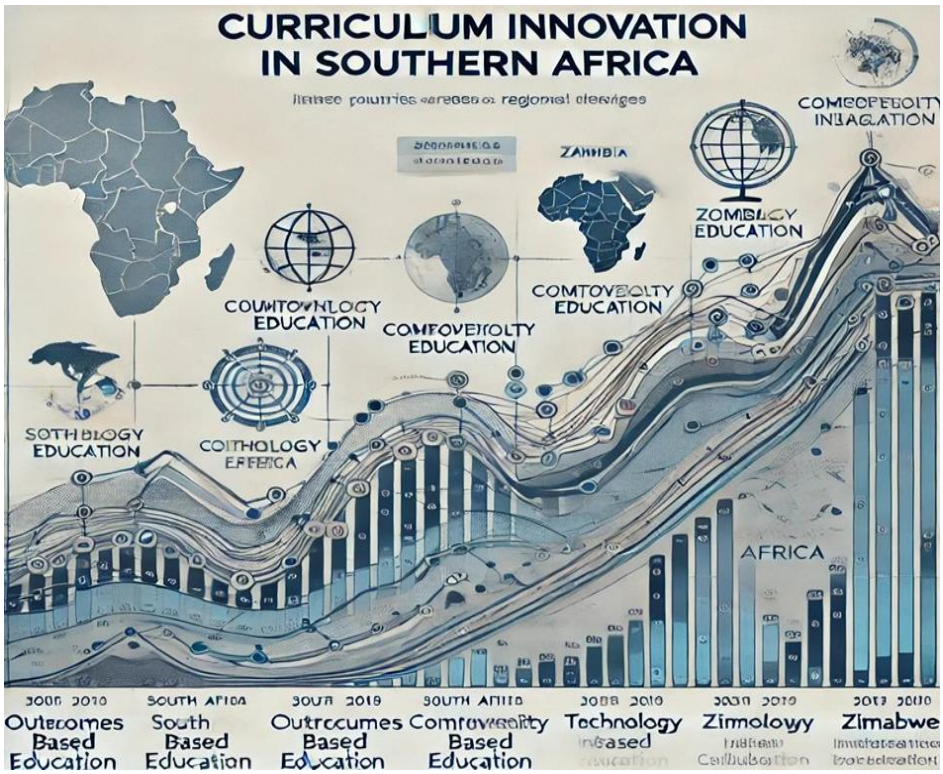
practices within some African contexts, and mathematical and problem-solving in the African context have long been cultural communities' practices in their social practices. This is why, by integrating such knowledge into the curriculum, the student can learn how to consider mathematics as a fluid cultural phenomenon of knowledge.

Nevertheless, the introduction of IKS into curriculum development in Southern Africa has its drawbacks. However, there is a significant hindrance regarding the absence of best practices for addressing the integration of Indigenous Knowledge Systems in curricula. Nevertheless, there is a general agreement about the significance of IKS; however, there needs to be more agreement on how it could be implemented systematically in school education. However, most teachers in the Southern African context need more training on mainstreaming IKS in their teaching practices across all academic fields, especially in more complicated areas such as mathematics. More instructional training must be needed to ensure the achievement of curriculum reforms at the teacher level. , as other scholars argue , when not well trained, teachers may have a hard time incorporating IKS in ways that are effective in helping the students learn and feasible.

The other challenge is in educational institutions where there is still much reluctance to change most classes, which still need to be centered on the West. This resistance is less about the implementation process than with members of educational policy-making, who may be highly reluctant to bring about profound changes to the system. Such resistance arises from structural factors within the education systems that are still discriminatory in promoting Western knowledge over indigenous knowledge systems . Addressing these challenges, therefore, means going beyond organization and policy support and, in principle, making society receptive to valuing Indigenous knowledge.

Nevertheless, applying IKS in education systems is the right way to enhance culturally relevant philosophy in education in Southern Africa. In fact, by embracing mathematics as a system of knowing the world that has developed in various cultures, curriculum developers can deconstruct the narrow and oppressive way mathematics is taught and learnt. In other words, what is envisaged is offering students an education in mathematics based on al-intimacy al-Adam al-calamity in a way that affirms and values the human endowment for cultural and intellectual capital in the region. This approach presents the probability of the progressive nature of an educational system that equally benefits and addresses the needs and goals of all learners.

Therefore, embedding IKS into the advanced mathematical curriculum in Southern Africa presents a suitable strategy towards removing colonialism and the relevance of education to the sociocultural realities of learners. As with any new model, some concerns should be considered; however, there are also advantages to such curriculum development, including increasing the students' appreciation for local cultures, increasing their interest and encouraging the creation of new, more culturally sensitive pedagogy. This points to the objective homework of enabling South and Southern Africa for ergonomics of education that integrates advanced divergent science and indigenous knowledge for higher learning for all students .



2. Materials and Methods

Please provide concise but complete information about the materials and the analytical and statistical procedures used. This part should be as clear as possible to enable other scientists to repeat the research presented. Brand names and company locations should be supplied for all mentioned equipment, instruments, chemicals etc. All the ethical permission associated in the research work must be specified. Indicate the statistical methods used and identify statistical significance using superscripts (* and **) following the data (*P<0.05, **P<0.01).

3. Results and Discussion

Indigenous Knowledge Systems and Early Mathematical Practices

Curriculum development in Southern Africa has indeed become an area of interest within the teaching reforms in the past few years, emphasizing the historical legacies of colonialism and apartheid. The impacts of the various socio-political systems in their individual histories left some marks on education and curriculum development and practice. The cry for curriculum development and, more so, after centering on delo-colonialization, seeks to bring an antidote to the more traditional imperialism-inclined views on education within the Western world. Subsequently, scholars and educators in the region have recommended that IKS be incorporated into school curricula to make education for everybody ethnocentric, multicultural, and responsive to the learners' diversity.

Therefore, implementing IKS into the literacy curriculum is a part of an even more significant de colonial coursework that aims to link educative systems to people of color and their cultural and historical roots. Curriculum innovation achieves one of the central goals of countering the disjuncture between curricular knowledge and young people's knowledge and experiences . IKS makes it easier for curriculum developers to develop meaningful lesson content for students since it integrates with their daily activities. The combination of formal education in school with indigenous knowledge will enhance how the students appreciate and embrace their Afrocentric values- referent to self and social reality while preparing them for the current global world.

When the learning becomes concrete and unique at the advanced level of mathematics curriculum implementation, the incorporation of IKS makes an enhanced curriculum development area. Then, mathematics education, which could be formally and academically defined as an ancient and universal science, benefitted from native numerical and geometrical knowledge and skills, theories, and problem-solving skills nurtured in different generations of African tribes. It also responds to mathematics as a privilege of, or better still, a product of, the Western world alone. It creates the perspective of mathematics incarnate within cultural and historical frameworks. Thus, the students can deepen their knowledge of mathematics and, thus, receive the global conception joined with the local view.

It has also been observed a need to transform the curriculum to embrace modern mathematics within African Mathematics knowledge. They argue that they understand that a good curriculum can point to the satisfaction of developing mathematical theory on the international level, responding to the local mathematical practices and knowing practices that were erased in mainstream education . For example, there are mathematical and problem-solving practices in some African cultures, and mathematical and problem-solving practices in the African cultural community have always embraced social practices. This is why, by incorporating such knowledge into the programme, the student can develop expertise in approaching mathematics as a cultural phenomenon of knowledge in learning.

However, as with any new idea, introducing IKS into curriculum development in Southern Africa has its demerits. However, there is a significant challenge to the need for existing guidelines to address incorporating Indigenous Knowledge Systems into curricula. However, there is much consensus about the importance of IKS, and much more is needed on how it should be introduced systematically into school education. Nonetheless, most teachers in Southern Africa require further professional development in mainstreaming IKS in their teaching across all disciplines, particularly in the more complex disciplines of content areas such as mathematics. Probably more instructional training might be required to address the achievement of curriculum reforms at the teacher level, as other scholars pointed out that if not adequately trained, teachers may struggle to incorporate IKS in a manner that assists the students to learn and can easily be implemented .

The other is that there is still so much resistance in educational institutions, especially in changing most classes, which must still be oriented towards the West. This resistance is not as linked to the implementation process as some educational policy-making entities and may be averse to changing the system. Such resistance stems from such structures within the education systems that are discriminatory in presenting Western knowledge as superior to indigenous knowledge systems . Mitigating such challenges requires moving from the organization and policy support level and, in principle, sensitizing society to appreciate Indigenous knowledge.

However, the practice of IKS in education systems is geared towards increasing culturally appropriate philosophy in the education system in Southern Africa. Indeed, by identifying mathematics as a form of knowing the world that exists in different cultures, curriculum developers can disestablish the suppressed and oppressive positivist view of mathematics being taught and learnt in most education systems. In other words, what is envisaged is the provision of students with an education in mathematics in the light of al-intimacy al-Adam al-calamity in a positive and culturally valuable way with an appreciation of the human endowment for cultural and intellectual capital in the region. As such, this approach exposes the possibility of an educational system's progressive features that provide equal value and services to accomplish learners' goals and needs.

Thus, the integration of IKS in the advanced mathematical curriculum in Southern Africa is the right approach towards the elimination of colonialism and practices relevance of education in the learner's sociocultural context. Like any new strategies, specific issues

should be taken into account; nevertheless, the blessings of such curriculum development are the following: the students are offered more opportunities to value a culture of the particular region, and such value can stimulate and grow the students' interest to develop new, more sensitive to local context, pedagogy. This shows the research needed for opening homework for South and Southern Africa for ergonomics of education that restructures the decolonized higher learning for the students .

Introduction of Western Mathematics through European Colonization

The introduction of Europeans to Southern Africa during the seventeenth and eighteenth centuries signified the beginning of a shift in the educational structure of that region, especially in Mathematics. European powers, mainly the British and the Dutch, extended institutional education in Europe and brought about a revolution in the architecture of education in the colonial context. During this period, the European systems of education and math were adopted, and practices were totally devoid of the black-induced knowledge that had been present before colonization.

In Southern Africa, the initial style of colonial education was mainly set to prepare a few selected locals fit to serve colonial masters' purpose. Essentially, this education entailed skills that would cultivate trade capacities that would underpin the colonial economy, especially arithmetic, bookkeeping, and other forms of field mathematics connected to commerce, trade and resource mobilization. Much credit must be given to the missionary agencies which accompanied missions in the region, especially in the 19th century, to set up schools that taught rudimentary mathematics of the European type. Teachers imposed known European applications of mathematics and devised curricula that would prepare colonials for administrative careers as the Continent's rulers rather than instilling in them general mathematical education.

In the past, has been highlighted that colonial mathematics education was designed to best suit the economic and administrative needs of the colonizing nations rather than for the childhood development of the colonized indigenous people . It is also important to recognize that this education system disadvantaged the remaining and far more numerous more significant Indigenous peoples who had similarly restricted education and limited access to more advanced mathematical learning. The system ensured only mere arithmetic skills and bookkeeping; thus, as it applied, only survived; a minority of children of settlers and local elites were privileged enough to receive formal arithmetic lessons. The rest of the indigenous people, on the other hand, had, in most cases, never any chance to even learn any formal education, let alone mathematical concepts.

Moreover, the concentration of European mathematics in commerce strained the connection between European mathematics and the original math techniques that existed before colonization in the African Continent. Pre-colonial Indigenous Africans had quantitative knowledge that was based on the conventional modes of handling their day-to-day experiences: field planting, animal rearing, and communal ceremonies. However, these systems were not embraced in the colonial education regime, and this contributed to the denial of Indigenous knowledge's intelligence compared to European knowledge.

The current impact was a split between conventional learning and traditional African knowledge. According to Mwaura (2019), the non-recognition of Indigenous mathematical traditions as part of the teaching-learning curriculum kept African cultures and knowledge systems in disarray. A generation of learners who were trained in European mathematics emerged but had no connection to the mathematical practices within their communities.

Therefore, the establishment of a mathematical curriculum in Southern African countries was due to European colonial education systems imported in the 17th and 18th centuries, which aided in the provision of education only for colonial needs. This system provided an enhanced thorough mathematical computation for mercantile industries, but a strand of higher education was barred for the Indigenous community. The above outcome manifested in a disconnection between formal mathematics education and

indigenous knowledge systems that persist in shaping education systems in many African nations..

Post-Colonial Mathematics Education and Integration of Indigenous Knowledge

In the middle of the twentieth century, most independent Southern African countries had to conduct considerable policymaking assessments of the educational systems they inherited from the colonial powers and start over to reconstruct their theories and values. Speaking at the symposium, scholars and educators highlighted some native knowledge systems to be adopted when developing educational systems relevant to the region and hence the call to adopt Indigenous knowledge systems, especially when developing education structure and content, as seen when the education theorists suggested ways through which integrated education structure could be promoted especially when adopting Indigenous knowledge systems in the course curriculum. This movement was geared towards redressing the education colonial legacies that had excluded Indigenous/post-colonial societies and equally aimed at transforming post-colonial societies by recognizing Indigenous knowledge/intelligentsia (Bashir & Smith, 2017). The assimilation of Indigenous knowledge into mainstream education was therefore presented as the right move in the effort to de-exploit education, especially with relation to curricula that have their origin in the Western world.

Indigenous knowledge systems became one of the central features of the post-colonial curriculum reform within mathematics education. Van der Walt (2018) has postulated that, on the one hand, many Southern African countries remained anchored in Western mathematics through educational systems; on the other hand, the importance of Indigenous knowledge for mathematics education was gradually unveiled. This recognition was not viewed symbolically but as making mathematics more culturally responsive to students from different backgrounds. Consequently, as Van der Walt (2018) defines it, Indigenous mathematical knowledge encompasses more than an accumulation of specific mathematical practices and concepts revealed in the Indigenous communities and entwined in their culture and language practices. Within this context, mathematics was approached not as the ahistorical edifice people often conceive it to be but as a field with its origins, resources, approaches, and learning experiences as situated in context.

In South Africa, for example, attempts to introduce Western and Indigenous mathematical practices to students that were well integrated were made under the project of the decolonizing curriculum. Such attempts were an attempt to close the gap between formal logical European mathematics and contextually situated mathematics of cultures indigenous to Africa (Soudien, 2012). Even as indigenous knowledge was positioned as a key priority for constructing an equitable mathematics curriculum, it was recognized that incorporating it would profoundly transform teaching and learning practices. This vision was to recognize the Indigenous knowledge system as an alternative to the Western mathematical system. However, the approach should complement the two so that other students who do not relate to Indigenous mathematics can benefit from the knowledge.

Chikoko et al. (2015) opine that convictions to integrate Indigenous mathematical practices into formal curricula have faced challenges. A lack of professional development among the primary facilitators for teachers to competently address the Western and Indigenous knowledge systems is pinpointed. Lack of resources, professional development, and skills among teachers, especially in rural and impoverished schools, means that these researchers' frameworks and frameworks remain out of reach for many teachers. There is more of this deficiency because the broader education system, in terms of its framework, still draws from the Western education model and has little space for indigenous knowledge systems even now (Fassin, 2018). More so, as Chikoko et al. (2015) have pointed out, policymakers are most likely to resist change with regard to such incorporation since they may regard indigenous knowledge as inferior or incompatible with the standards of foreign institutions. This resistance comes from a firmly held perception of the Western form of education as the yardstick for education and

development, informing educational restructuring processes in many Southern African nations.

Still, continuous discussions of decolonizing mathematics instruction demonstrate the possibility of introducing a new perspective devoid of ethnocentric assumptions and better aligned with the local culture. The effort to include indigenous knowledge in the mathematics classroom is not only a scholarly process; it is a political and social act since it attempts to correct the harms done by colonial education systems. Despite these hurdles, educationists, policymakers and scholars have remained pallets for curriculum changes that incorporate the mathematical cultures of Southern Africa to develop an academic-oriented curriculum that at the same time respects culture (Bashir & Smith, 2017).

Mathematics Education in the Contemporary Context

However, in the past decade or so, particularly in Southern Africa, there has been growing emphasis on using indigenous knowledge to deconstruct colonialism in education. The author, such as Maphosa (2019), supports the rationale that including indigenous mathematical knowledge can improve the likelihood of mathematics for students from cultural backgrounds. Indigenous practices, counting methods, geo, metrics and patterns found in African art, to name but a few, can be incorporated into the curriculum and make the content area more culturally relevant for the students.

According to Nhemachena and Jansen (2020), there is a tendency to adopt indigenous knowledge practices alongside the modern approach to theoretical mathematical knowledge in an educational setting. For instance, the conventional African forms of geometrical shapes or the initial abacus of counting patterns used by blacks can form the foundation for teaching such sets as algebra or fractals. This approach not only recognises the mathematical achievements of indigenous cultures but also contributes to creating a better social environment that accepts students as members of their cultural groups.

Benefits of Integrating IKS into Advanced Mathematical Education

Incorporating IKS in advanced mathematical education has several educational and cultural values. A chief gain is that mathematics becomes more familiar and understandable for learners from indigenous peoples because methods of pedagogics to teach math seem irrelevant to indigenous learners. Due to the utilization of IKS, students can establish mathematics links about their cultures, as postulated by Van der Walt (2018). The indigenous patterns of design and the traditional system of measurement can be taken as the basic framework on which the learners may find the concepts of symmetry, algebra and calculus more interesting.

Moreover, there will be an improved understanding of the inclusion of indigenous philosophies into mathematics embraced by students so that they will see the cultural value and global aspects of mathematics. Besides extending students' mathematical knowledge, this two-pronged strategy enhances the children's self-identity and cultural associations, as Maphosa (2019) has pointed out. The social validity of Indigenous knowledge in mathematics as a tool for improvement may help empower and enhance the student's motivation to enhance their education through post-graduate levels in Mathematics and related fields..

Challenges in Integrating IKS into the Mathematics Curriculum

Nevertheless, including IKS in advanced mathematics education in Southern Africa is challenging. One challenge is that there needs to be a systematic and coherent pattern for integrating Indigenous knowledge into modern mathematics curricula. Most education systems continue only to acknowledge and encourage Western ¡ñ mathematical culture, thus hardly providing room for local knowledge. The authors support this by saying that Chikoko et al. (2015) argue that educational authorities and policymakers always resist Indigenous knowledge since they consider it inferior and less scientific than Western knowledge.

This is relatively rare when compared to the other challenges that have been discussed above. There is also a need for more professional development in teachers. Teachers may need more competencies to make indigenous knowledge systems acceptable to supplement formal mathematical learning. This implies that there is a need for proper training of teachers through training colleges to have the appropriate knowledge and methods regarding indigenous knowledge and modern views on mathematics. Furthermore, there are still limitations to the availability of resources such as text and other teaching materials, including texts that fill the interface between IKS and higher-level mathematics.

Opportunities for Curriculum Reform and Teacher Development

Despite these challenges, significant opportunities exist for curriculum reform and teacher development. There is growing recognition of the value of Indigenous knowledge in educational contexts and an increasing willingness to explore alternative pedagogies. Nhemachena and Jansen (2020) suggest that partnerships between Indigenous knowledge holders, mathematicians, and curriculum developers could facilitate the creation of a curriculum that balances Indigenous and formal mathematical knowledge.

Professional development programs for teachers are another important opportunity. These programs should equip educators with the knowledge and tools to integrate IKS into their teaching practice. Collaborative workshops and the development of resources that combine indigenous knowledge with advanced mathematical principles can also help educators gain confidence in delivering such a curriculum.

A Framework for Integration

Therefore, the need to fully incorporate IKS into advanced mathematical formula development will require a framework. This framework should include several key elements:

1. Cultural Relevance: Paying attention to the trove of cultural references to ensure that powerful mathematical ideas are set within the framing of indigenous Okoronkwo art, architecture and astronomy.
2. Collaborative Approach: Including indigenous knowledge custodians, teacher trainers, and mathematicians in designing and developing suitable indigenous material.
3. Pedagogical Flexibility: Teachers should be encouraged to take an open approach to integrating what is taught in the classroom with indigenous and Western ideas in mathematics that students can easily understand and appreciate.
4. Policy Support: Government curriculum development policies should provide finance for integrating IKS into the curriculum, training teachers to teach IKS insistently, and developing teaching aids that are pro-IKS.

4. Conclusion

Adopting Indigenous Knowledge Systems (IKS) into complex formula systems of technological and mathematical advancement is a potential area of curriculum development revolution in Southern Africa. The cultural background of the region and its traditions are a worthy starting point for developing means for improving the results of mathematics teaching and encouraging the emergence of new ideas in addressing modern problems. Implementation of IKS into the contents of Mathematics can help teachers close the gap between the already existing gaps between cultural practices and the Western way of teaching and learning Mathematics, thereby enhancing appreciation and understanding among the young generation.

It also helps to create a more intelligent school for the education of local communities and respect for modern society's practices while preparing the students for the globalization process. This fosters critical evaluation skills, creativity, and problem-solving skills backed by indigenous and Western chains of reasoning. Besides, such a curriculum can enable students to make positive use of the programme and apply mathematical

knowledge in cultural and relevant contexts to effectively support their societies and communities in general.

However, to make this work, there is a need for the collective effort of educators, policymakers, community, and research so that IKS can be brought into its proper perspective. The former includes teacher training, curriculum reform, and research focusing on Indigenous mathematical practices, which are crucial in forming a framework. In the end, if Southern Africa embraces indigenous and modern mathematical knowledge, then Southern Africa can lead the way towards a fresh and entirely new Math Education which is culturally sensitive, to the benefit of producing a new generation of learners capable of solving world and regional problems.

Recommendation

The possibility of bridging IKS and advanced mathematical formula formation is an innovative educational opportunity nicely situated in Southern Africa. The following recommendations can guide curriculum experts in shaping the future of education in this regard:

1. Acknowledge Indigenous Knowledge as a Valid System of Thought: First and foremost, there is a dire need to appreciate the IK systems for what they are, that is, as systems that exist in parallel with what has conventionally been characterized as scientific and mathematical systems. It is important to recognize the complexity of mathematics embedded in Indigenous societies, such as the use of geometrical aspects in Indigenous arts and buildings and even the allocation of resources.
2. Curriculum Framework Development: Establish a sound guided framework that integrates IKS into the curriculum at different levels of education. This may include using Indigenous elders, university scholars, and mathematicians to employ and develop cross-cultural education to intersect the Math concept with pre-existing knowledge. While developing the curriculum, it is possible to make sure that besides studying IKS as one of the important components of the African people and their culture, the students will also learn the newest methods to solve different logical tasks in mathematics.
3. Interdisciplinary Approach: Promote solutions where mathematics and quantitative processes integrate with culture, history, and anthropology. This would allow students to understand how indigenous systems have developed their calculation methods in Agriculture, Astronomy, and ecology.
4. Pedagogical Methods: Use other culturally sensitive approaches to teaching/learning that are sensitive to Indigenous people's knowledge. This could involve folktales, narrative histories, and uses of numbers drawn from the contexts of real life. Involve the students in activity and discovery-based learning practices that will seek to relate IKS to complicated mathematical concepts.
5. Research and Development: Call for more studies concerning mathematics content in Indigenous communities. It is possible to explore more concepts in Indigenous people for various purposes, e.g., geolocation, measurement of time, or management of resources, or to analyze concrete solutions discovered by natives. This may help formulate new mathematical theories or even higher mathematical formulae that embody Indigenous intelligence.
6. Collaborations and Partnerships: The following relationships should be developed: uni-collaboration-university: The university should seek partnerships with local Indigenous peoples and relevant government departments to finance the promotion of IKS in tertiary education. These could also enhance the creation of capacity-building activities for teachers to help them implement IKS practices in their learning institutions.
7. Evaluation and Feedback: These are the ways in which any mechanism necessary for evaluation and feedback during the integration of IKS into the curriculum is put in

place. This includes feedback from the Indigenous people, students, and educators to make the integration progress more reverent, authentic, and useful to everybody.

8. Global Engagement and Adaptability: Last, localize the integration of IKS into mathematical curricula as a worldwide endeavour. Promote ST philanthropy by ensuring Southern African institutions expose their experiences with other institutions globally, thus widening the depth of mathematics.

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