Madu, Cletus Ifeanyi (2024). MATHEMATICS AS STORY TELLING (MAST): A FOCUS ON TEACHING AND LEARNING ALGEBRA. WATARI Journal 8(1) Pp. 46-49

MATHEMATICS AS STORY TELLING (MAST): A FOCUS ON TEACHING AND LEARNING ALGEBRA

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Abstract

Mathematics education does not seriously involve indigenous culture of Nigeria, thus students continue to be the most mathematically disadvantaged group especially at the secondary school level. Conventional wisdom with regard to Indigenous Mathematics education is to utilize practical and visual teaching methods, yet the power of Mathematics and the opportunities it brings for advancement lie in symbolic understanding. This paper dwells on a teaching approach Math As Story Telling (MAST) which can assist students understand algebra through creating and manipulating their own symbols for equations. It discusses effective indigenous Mathematics teaching. It describes the MAST approach and analyses its semiotic processes, discusses applications of the approach, and draws implications for indigenous Mathematics learning. The paper recommends that collaboration is required to meet up with language and other problems that the approach will normally encounter when adapted to a new cultural setting which includes political, mathematical content, community based and pedagogical. This collaboration, the author emphasises should be among teachers, researchers and community where the approach is to be adopted.

Introduction

The search for ways of reversing Mathematics underperformance has been on for many years yet apparently the situation appears intractable. This is because Mathematics teaching in Nigeria is Eurocentric **(Yusuf & Madu, 2011)** and does not take into account the experiences and cultural setting of the learner. Students perceive Mathematics as a subject for which they must become 'white' to succeed **(Matthews 2005)** and which can challenge their indigenous identity (**Pearce 2001)**. Teachers tend to have low Mathematics expectations of students, blaming underperformance on absenteeism, social background and culture rather than on themselves and the education system **(**Madu, 2010**)**. As a result of this, few students present themselves to study Mathematics at the tertiary level.

This paper has endeavoured to contextualize Mathematics pedagogy with indigenous cultural perspectives to overcome systemic issues of indigenous marginalization; and instill a strong sense of pride in students' indigenous identity and culture since both are prerequisites for Mathematics improvement. Although we can contextualize algebraic applications through modelling, but it could not be so apparent for the teaching and learning of formal algebraic structure and symbol manipulation.

There is awareness that effective Mathematics teaching and learning is crucial for improvement in other sciences, business and technology. Mathematics performance can also determine employment and life chances. However, there is some ambivalence in the literature regarding the nature of effective indigenous Mathematics teaching in Nigeria. Students appear to learn best through contextualized concrete "hands-on" tasks and have greater sensitivity and success in dealing with visual and spatial information compared to verbal **(Barnes, 2000).** They also learn by observation and non-verbal communication. However, these assertions may be objects of indigenous approach for students being taught. They may not have the words to describe many mathematical ideas **(Roberts, 1998)** and the words they have may be ambiguous **(Durkin & Shire 1991)**.

School programs can dramatically improve indigenous learning outcomes. This they can do by reinforcing pride in indigenous identity and culture; encouraging and highlighting the capacity of students to succeed in Mathematics challenges and expect students to perform, and provide relevant educational context in which there is Indigenous leadership **(SARRA, 2003)**. Teachers with little understanding of indigenous culture can have difficulties with contextualization and reject it in favour of familiar Eurocentric approaches **(Connelly, 2002**). Thus, building productive partnerships between indigenous teachers and non-indigenous teachers will assist in bringing the best out of both. This will also increase the success story that focuses on structural learning of mathematics **(Baturo & Cooper, 2004)** and students will tend to be holistic learners; a learning style that appreciates overviews of subjects and conscious linking of ideas that will make students become interested in using mathematics as a way of gaining high status employment.

What is MAST?

MAST is an approach to teaching that utilizes indigenous knowledge of students in some activities like sports, driving, art and dancing as a starting point for building understanding of Arithmetic symbolism in a way that can be easily extended to algebraic symbolism. MAST is the first product of the Minjerribah Maths Project (explained later in this paper) which was set up to answer the following questions:

- Can we improve achievement and retention in indigenous Mathematics by refocusing mathematics teaching onto the pattern and structure that underlies algebra?
- Are there indigenous perspectives and knowledge we can use?
- Can we at the same time provide a positive self-image of students in their own environment? (Ernest 2005).

The answer to the dilemma of contextualising the teaching and learning of algebra is to focus on representing mathematical equations as stories which leads to contextualising of mathematical symbols. Thus, we can develop an approach to symbolisation for students to create their own symbols drawn from their socio-cultural background and to describe these stories as a precursor to working with the accepted Mathematics symbols.

MAST is thus an attempt to work from the story-telling world of the students to the formal world of algebra by experiences with the creation of symbols that have personal meaning. The story telling starts with simple arithmetic but moves quickly to algebraic thinking. It enables students to bring their everyday world of symbols into Mathematics. The approach has five steps.

Step 1: Students explore the meaning of symbols and how symbols can be assembled to tell and create a story. This is initially done by looking at symbols in indigenous situations (e.g., exploring and understanding symbols in paintings) and then creating and interpreting symbols for simple actions (e.g. walking to and sitting on a desk).

Step 2: Students explore simple addition story by acting it out as a story (e.g. two groups of people joining each other). A discussion is then generated to identify the story elements such as the different groups of people and the action (the joining of the two groups (addition) and the consequences of the action (the result of the joining - addition).

Step 3: Students create their own symbols to represent the story. This step could be done in a free style manner. However, one can opt to take a more structured approach by using concrete materials which are familiar to the students like sticks to represent the objects (or people) in the story. The story is then created by allowing the students to construct the two groups of people with the concrete materials; construct their own symbol for "joining two groups" and lay this out to represent the action of the story. In a similar fashion, the students then construct their own symbol for "resulting in" or "same as" to tell the story of what happens after this action has taken place.

Step 4: Students share their symbol systems with the group and any addition meanings their symbols may have. For example, in Figure 2, the student's "joining" symbol was a vortex that sucked the two groups together. The teacher then selects one of the symbol systems for all the students to use to represent a new addition story. This step is important to accustom students to writing within different symbol systems and to develop a standard a classroom symbol system.

Step 5: Students modify the story (a key step in introducing algebraic ideas) under direction of the teacher. For example, the teacher takes an object from the action part of the story. The teacher asks whether the story still makes sense, which normally is a resounding no, and then challenges the students by asking them to find different strategies for the story to make sense again. There are four possibilities:

a. putting the object back in its original group,
b. putting the object in the other group on the action side,
c. adding another action (plus 1) to the action side, and
d. taking an object away from the result side.

The first three strategies introduce the notion of compensation and equivalence of expression, while the fourth strategy introduces the balance rule i.e. equivalence of equations. At this step, students should be encouraged to play with the story, guided by the teacher, to reinforce these algebraic notions.

Explanations to the 5 steps Analysis

The MAST experience minimizes the effect of the Ernest's conventionalization process. Ernest (2005) so that students can freely express their creations and the meaning behind their symbols. The approach is designed to allow students to engage with Ernest's second and third processes, namely, transformation and publication, for symbols they create before they were required to undertake the full four processes for the universally accepted

mathematical symbol system. Thus, the MAST steps could be considered as refocusing on creativity and the expression of this creativity. MAST steps 3 and 4 are the essential steps that focus on transformation and publication.

Advantages of MAST

1) It enables students to create their symbols with personal meaning, by working backwards from meaning to symbol and not forward from symbol to personal meaning as usually happens when learning the normal symbols.
2) It enables students to reinforce the personal initiation of students' meanings through sharing them with other students and sharing in the other students' symbols, to see the personal relation to the collective and not in the collective. As such, the steps are a powerful semiotic method for teaching and learning mathematics because they are driven by a primary focus on signs and sign use and focused on how the students individually create, appropriate and openly express these symbol systems.
3) The transformation and publication are important processes for MAST to encompass because they allow students to see beyond the well-known pathological outcome of education in which learners only appropriate surface characteristics without managing to transform them into part of a larger system of personal meanings. It also helps students to appreciate how a collective action regulates and standardises symbols and their uses.
4) The variety of symbols experienced in the publication process in MAST step 4 offers the opportunity for students to investigate commonalities across symbol systems, that is, to abstract at a high level. This develops the essence of the semiotic approach (i.e., the meaning of symbols, the relationships between symbols, and their underlying rules and applications).
5) MAST steps 4 and 5 involves students discussing and critiquing each other's symbol systems (being proponents and critics for each other) and therefore, having the potential to develop high learning. As such, MAST introduces, very early in the learning of symbols, the capacity to be creative and generate new expressions and possibly new meanings and structures within symbol systems.

Why use MAST more in Algebraic Development

Algebra is the basis of all mathematical expressions and this has stimulated the author's interest on algebra for three reasons:

a. Algebra is the basis of many high status professions;
b. Algebra is based on generalising patterns and structure skills with which students may have an affinity because their culture contains components (e.g. kinship systems) that are pattern based and which may lead to strong abilities to see pattern and structure and
c. Algebra is the master of Mathematics as it makes mathematics simple because one could see the pattern and structure or the generalisation of algebra much clearer than the detail of Arithmetic.

Conclusion

The five MAST steps are illustrations of how the approach could be used to introduce students to algebraic ideas, while the analysis indicates the implications of the approach for bridging the gap between Arithmetic and Algebra. Creating one's own symbol system appears to be an effective way to introduce algebraic thinking to students in their local indigenous setting. It meets all the requirements for relational and high level understanding. With step 1, MAST contextualized algebraic symbolization **(Matthews, 2005)**, is an experience for both teachers and students as they explore symbols in the indigenous world view.

Such contextualization could be difficult for non-indigenous teachers (**Connelly, 2002**) but it would certainly make learning two-way strong, from teacher to students and students to teacher giving a positive outcome for indigenous learning **(Pearce, 2001)**.

Seeing indigenous knowledge underlying the most abstract of Mathematics could well lead to growth in self confidence and development of positive self image for indigenous students that, in turn, may well assist to reverse indigenous Mathematics underperformance **(Sarra, 2003)**.

Interestingly, the implications for MAST are wider than indigenous students can imagine. MAST appears to be a powerful way to assist all students' move from Arithmetic to Algebra by taking emphasis away from foreign systems; it shifts the emphasis to algebraic patterns and structure within something that is familiar. Step 4 is designed so that, conversation can be fluid and shifting in its actualization with near spontaneous verbal responses as well as other modes of response sought and encouraged. This, along with each student creating their own symbolism, should provide a feeling of freedom within the MAST activity. In any case, MAST is a worthwhile activity for the way in which it utilizes agency in initiating action.

However, it would be thoughtless not to mention an uncertainty in the approach which is the process of translating from developed personal symbols to the conventional. Language can be simultaneously both a support and a hindrance to students' learning of Mathematics. When students have sufficient fluency in the Mathematics register so that they can discuss their ideas, they become chiefs who are able to think mathematically. However, learning the Mathematics register in an indigenous language is not a simple exercise and involves many challenges not only for students, but also for their teachers and the wider community.

Recommendation

Because MAST encompasses games and other mind-catching and stimulating aspects that appeal to children, it is highly recommended for all teachers of Mathematics especially at the Lower levels of Primary and junior secondary schools. Collaboration is required to meet up with language and other problems in indigenous Mathematics classrooms which include political, mathematical content, community based and pedagogical. Inter-disciplinary cooperation should be encouraged. For instance, MAST can be practiced during a practical Physical and Health Education class. This collaboration should be among teachers, researchers and community where the approach is to be adopted. It is very important to point out the place of inadequate time during mathematical instructions. Thus it is recommended here that Mathematics teachers must make out time outside the official classroom setting to be able to improve the students' participation in the use of MAST.

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