LEARNING

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PROFESSOR TOLUWALOPE WALE YOLOYE

DEDICATION

To the Chapel of the Resurrection, University of Ibadan and Our Saviour's Chapel, IITA

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The Editor

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INSTRUCTIONAL MATERIAL IMPROVISATION FOR ENHANCED MATHEMATICS LEARNING

Joshua O. Adeleke

Introduction

It should be noted that the need to broaden educational opportunities, especially in developing countries like ours has been highlighted since the Jomtien Conference on Education For All in 1990. The international commitment to that effect stems from an understanding that education holds the key to individual and national development. This is to be realized through improvement of the attitudes, beliefs and practices that are inimical to human and national progress and the enthronement of democratic values among citizens. Thus, the National Policy on Education (FRN, 2004) states that "the Government recognizes education as an instrument par excellence for effecting national development." Apart from these plausible reasons for equitable access to education, another fundamental reason for such equity, According to Universal Basic Education Commission (2008) is the fact that education is a right in itself as enshrined in the Child Right Act, 2003. While giving this right, Mathematics is one of the major subjects every student must learn at both primary and secondary school levels. Thus, its teaching should be of importance to all the stakeholders in education industry.

A strong positive link should exist between the quantity and quality of instructional materials improvised by the teacher for the teaching of mathematical concepts. The major function of the school is teaching (Popoola & Olarewaju, 2012). Effective teaching and good performance is possible if the necessary instructional teaching facilities are made available. Research works in the field of learning psychology reveal that the use of instructional materials in mathematics has several advantages mainly because of two senses (seeing and hearing) involved. All learning is based on perception. Instructional materials are the medium by which the senses gain information from the environment. According to Ibrahim (2010), more learning occurs when information is received simultaneously through the two senses rather than in a single medium.

When these mathematics teaching facilities are available, they provide visual access to a process or technique and provide common framework or experience

to a large number of learners (Suleiman, 2001). Instructional facilities also enable teachers and learners to have easy and repeated reproduction of an event or procedure, they promote illusion of reality, provide visual access to a process or technique, create impact, focus attention on highlight of key points, save time by limiting the use of wordy explanations, gain and hold the attention of the learner and facilitate the understanding of abstract concepts (Nkuuhe, 1995; Ayodele, 2001; Popoola, 2006). Tincton (2006) found that instructional materials are successful in raising examination scores, improving students' attitudes and lower the amount of time required mastering certain materials. Instructional materials enhance learning at all educational level.

Awojobi (2000) found out that instructional materials promote meaningful learning of mathematics and improves students' mathematical skills and supplement other learning experiences especially in the classroom. Furthermore, learning is enhanced when materials are organized and that organization is evident to the students. Instructional materials facilitate easy and quick understanding of the subjects' contents. Ibrahim (2010) discovered that instructional materials facilitate effective teaching and learning of mathematics. Instructional materials, to the extent to which they are available and used, make the teachers' efforts to impart knowledge easier while learners are also supported to achieve learning objectives easily. An appropriate and good instructional material goes a long way to remove apathy, serves as a substitute for lack of books and arouses the learners' interest (Abdullahi, 1998). Akanbi (1999) asserted that they are important tools for enriching, visualizing, amplifying, transmitting and accelerating the teaching and learning of mathematics.

Teacher attitude towards the production of improvised materials

Teacher attitude was defined by Parker (2011) as expectation of a positive or negative outcome of using improvisation in the classroom based on their perception of how the academic and social community would respond to improvisation in the curriculum. Several survey studies have revealed teacher's positive or negative attitude towards improvisation of materials for teaching and their consequences on recorded success in completing the teaching tasks (Fennema & Sherman, 1976; Wehr-Flowers, 2006). Attitude was investigated because teacher attitude toward a subject influences what is taught, how it is taught, and who is expected to be able to learn it (Darling-Hammond, 2005). Social perspectives of the aims of education in regard to how a subject should be taught often affect what and how teachers choose to teach (Kelly, 2009).

Attitude of teachers toward improvisation materials for teaching mathematics therefore, may influence their teaching performance. According to Goldstaub (1996) and Hamann and Gillespie (2009), improvisation is a teaching tool that can be accessible to teachers from many backgrounds. However, Goldstaub also observed that some teachers see improvisation as something that people either do or do not do. Therefore, attitude is the teacher's expectation of a positive or negative outcome based on social acceptance and student achievement. Also attitude gave some insight into teacher perceptions of cultural and personal expectations (Parker, 2011)

Burnard (2000) found that students' and teachers' conception of instructional materials improvisation are closely related. The way a teacher values and perceives improvisation will influence the ways students view improvisatory experiences. Eventually, students should develop their own understanding by using improvised materials during teaching and learning process. In reference to the importance of using improvisation in Mathematics education, when a teacher provides students with the readiness and skills to create and improvise their own materials, mathematical skills become the property of the students themselves, and this should represent the ultimate goal of all mathematics teachers. Until students have formed personal experiences and understanding of improvisation, their concepts will most likely be based on their teachers' values. Overcoming challenges around difficulty and appropriateness of using improvisation may influence teachers' value. The merit of improvisation also, in sequential learning could contribute to positive teacher attitude.

According to Parker (2011), educators are challenged to learn while teaching when a relatively unfamiliar concept is introduced as a teaching strategy. According to Sherin (2002), the attitude a teacher has when approaching a new device may influence the success of the tool's incorporation. In her study, Sherin described the way teachers approached content knowledge and pedagogical knowledge in mathematics education reform. She found that teachers' development in pedagogical content knowledge was paired with student learning. When teachers were challenged to incorporate new materials, develop adaptive teaching styles, and direct student-centered instruction, they learned to formally consider what pedagogical devices would best fit a situation. As new pedagogical ideas are developed and tried, teachers who have open and willing attitudes towards learning and adjusting content and pedagogical knowledge may be more successful. Potentially, teachers can gain as much Mathematics and pedagogical growth as students from using improvisation as a teaching tool, but attitude may be a factor in teachers' capacity to adaptation.

A teacher's attitude will have an effect on what and how curriculum is used in the classroom (Darling-Hammond, 2005). Though moving away from tradition and personal experience may be challenging, teachers are in a position to accept and teach new values (Azzara, 1999; Riveire, 2006). Teachers need to be involved and supportive if students are to learn mathematics and use improvisation (Aaron, 1980; Baker, 1980). Below are some of the factors that militate against teachers' attitude towards improvisation according to Arhin and Asimah (2006) as presented in Parker (2011).

- The innovativeness on the part of teachers could affect mathematics teachers' attitudes either positively or negatively in the production of improvised materials. Some teachers are rigid that they cannot come out with any artifact on their own in place of the unavailable teaching and learning instructional materials. And such teachers are not resourceful and lack creative thinking which makes them feel lazy in producing improvised instructional materials to enhance his or her teaching.

- Some teachers think that the materials that could be used to produce improvised instructional materials are difficult to come by. That is, materials which could be used for the production of improvised instructional materials could not be found in the local scene.
- Some mathematics teachers are of the view that, the use of improvised instructional materials during teaching and learning process brings about lowers of standards of mathematics.
- Some mathematics teachers also feel reluctant in producing improvised instructional materials with the idea that, improvised materials would make learners not to be abreast with the use of modern equipment.
- The production of improvised materials increases the work load on teachers. Therefore, to produce an instructional improvised material instead of using original material; one would spend more time outside the set time frame and also extra work which needs extra attention and money.

Problems faced by Mathematics teachers when improvising instructional materials

Arhin and Asimah (2006) also identified some problems mathematics teachers face while improvising materials for teaching mathematics.

- There appears to be a lack of organized improvisation instruction in Mathematics classes. Teachers do not seem to be making class time available for students to participate in creative, improvisatory activities (Azzara, 1999; Barkley, 2006). Mathematics education has been criticized for over-emphasizing abstract and theoretical teaching and neglecting creativity. The problem still persists today. Even when teachers attempt to use improvised materials in their lessons, particularly at the lower levels of educational system, improvisation may be used "superficially and unsystematically" because many mathematics teachers are unaware of the ways improvisation can be used effectively.
- Authors in the field, suggest a few reasons improvisation has not been implemented as effectively as possible. According to Riveire (2006), improvisation may be sacrificed due to shortages of resources, including time, money, and lack of teacher experience in improvisation. But in preparing children to live in an increasingly technological, manufactured, and depersonalizing world, it is imperative that mathematics teachers make the time and effort to enrich children's lives. Teachers can be the ones to expand children future through aesthetic awareness and creative thinking. This is a weighty responsibility, true; but it is, after all, what teaching is all about. Purposeful improvisation offers one of the richest sources for its fulfillment.
- Though teachers must consider the amount of class time available while planning the scope of curriculum, improvisation is a skill that can contribute uniquely to a student's learning experience and creative thinking.
- The secondary reason mathematics teachers may not incorporate improvisation is lack of personal experience (Riveire, 2006). As teachers emulate the methods

used in their own education, lack of improvisation in their training may discourage them from using it (Riveire, 2006; Volz, 2005). When a teacher is fearful, lacks confidence, or does not value the use of improvised materials based on previous experiences, there is a higher likelihood it would not be included in his or her instruction.

- When the resources needed to produce improvised instructional materials are difficult to come by, teacher would not bother to improvise. In producing improvised instructional materials some mathematics teachers find it difficult in locating the necessary or readily available materials in the local environment.
- Lack of technical know-how and creativity is another setback that hinders the production of improvised mathematics instructional materials. That is many mathematics teachers lack knowledge or idea in producing improvised instructional materials, hence would not improvise in the absence of the original materials.
- Financial constraints also impede the production of improvised instructional materials. Some of the materials needed in producing improvised materials needs to be purchased and are very expensive for mathematics teachers to afford
- Getting assistance from the locality is another factor that prevents some mathematics teachers from producing improvised instructional materials. In making improvised instructional materials, it is the duty of teacher to seek assistance or consult resource persons like carpenters, blacksmiths, goldsmiths, etc., which sometimes is difficult in reaching or getting such personnel in the environment.
- In going round to gather materials and information in the environment to produce the improvised instructional materials, much time is spent than buying the readymade ones and this prevents mathematics teachers from producing improvised materials.
- The class size can also deter mathematics teachers from producing the materials. Thus if the class size is so large, the production of the improvised instructional materials could be of great challenge to the teachers because a large number of improvised instructional materials need to be produced thereby deterring some teachers from producing it.
- Some mathematics teachers see improvisation to be an extra duty for them. Some teachers think their work is to go to the classroom to teach. For this reason, they tend to ignore improvisational activity with the notion that it is not part of their work.

Roles of instructional Materials

Instructional materials, have the potency to fulfill the following roles if improvised by mathematics teachers and effectively used. They:

enhance student's natural interest in mathematics and their disposition to use it to make sense of their physical and social worlds. Students show a natural interest in and enjoyment of mathematics. Relevant instructional materials such as abacus, three dimensional shapes (cylinder, cone, plastic ball

e.t.c.) prompt activities, where instructional materials often explore mathematical ideas and processes; for example, they sort and classify, compare quantities, and notice shapes and patterns.

build on student's experience and knowledge, including their family, linguistic, cultural, and community backgrounds; their individual approaches to learning; and their informal knowledge. To achieve equity and educational effectiveness, mathematics teachers must know as much as they can about differences existing among students and work to build bridges between their varying experiences and new learning by using appropriate instructional materials.

support to base mathematics curriculum and teaching on knowledge of student's cognitive, physical, and social-emotional development. Beyond cognitive development, teachers need to be familiar with students' social, emotional, and motor development, all of which are relevant to mathematical development. To determine which puzzles and manipulative materials are helpful to support mathematical learning, for instance, teachers combine their knowledge of students' cognition with the knowledge of psychomotor development.

strengthen students' problem-solving and reasoning processes as well as representing, communicating, and connecting mathematical ideas. The process of making connections deserves special attention. When students connect number to geometry (for example, by counting the sides of shapes, using arrays to understand number combinations, or measuring the length of their classroom), they strengthen concepts from both areas and build knowledge and beliefs about mathematics as a coherent system.

make the curriculum coherent and compatible with known relationships and sequences of important mathematical ideas. The content areas and their related big ideas, however, are just a starting point. Where does a teacher begin to make learners understand an idea such as "counting" or "symmetry,"? The problem of how do I start is overcome when appropriate teaching materials are used to open mathematics instructional activities.

provide for students' deep and sustained interaction with key mathematical ideas. Effective teaching allows children encounter concepts in depth and in a logical sequence. When relevant instructional materials are improvised and used such depth and coherence that allow the students to develop, construct, and reflect on their mathematical understandings are achieved. For example two dimensional rectangular shape should be shown to learners before introducing the concept of cuboid.

integrate mathematics with other activities and other activities with

mathematics. Also important is weaving mathematics into students' experiences with literature, language, science, social studies, art, movement, music and all parts of the classroom environment. For example, there are books with mathematical concepts in the reading corner, and clipboards and wall charts are placed where students are engaged in science observation and recording (e.g., measuring and charting the weekly growth of plants).

provide ample time, materials, and teacher support for students to engage in play, a context in which they explore and manipulate mathematical ideas with keen interest. Play does not guarantee mathematical development, but it offers rich possibilities. Significant benefits are more likely when teachers follow up by engaging students in reflecting on and representing the mathematical ideas that have emerged in their play. Teachers enhance learners mathematics learning when they provide instructional aids and ask questions that provoke clarifications, extensions, and development of new understandings. Block building offers one example of play's value for mathematical learning. As children build with blocks, they constantly accumulate experiences with the ways in which objects can be related, and these experiences become the foundation for a multitude of mathematical concepts--far beyond simply sorting and seriating. Classic unit blocks and other construction materials such as connecting blocks give students entry into a world where objects have predictable similarities and relationships. With these materials, children reproduce objects and structures from their daily lives and create abstract designs by manipulating pattern, symmetry, and other elements. Students perceive geometric notions inherent in the blocks (such as two square blocks as the equivalent of one rectangular unit block) and the structures they build with them (such as symmetric buildings with parallel sides). Over time, children can be guided from an intuitive to a more explicit conceptual understanding of these ideas.

actively introduce mathematical concepts and methods through a range of appropriate activities. The way a teacher introduces and modifies games can promote important mathematical concepts and provide opportunities for student to practice skills. For example, teachers can modify any simple board game in which players move along a path to make the game more mathematically powerful and more appropriate for students of differing developmental levels. Use of materials also requires intentional planning and involvement on the teacher's part. Support students' learning by thoughtfully and continually involving all learners' mathematical knowledge and skills.

Construction of instructional materials for effective mathematics teaching

The cry in many primary and secondary schools is lack of instructional materials. The lack is always traced to the government. However, the lack of adequate and appropriate instructional materials necessitates that every teacher should be innovative in order to

improvise relevant instructional materials that are appropriate to topics in mathematics they teach. There are various methods of constructing instructional materials that will cost less or not.

(a) Collection of discarded materials: There are many items in students' homes that can aid mathematics learning if teachers assist them to establish the relationships. Students can be asked to bring the following items to school:

(i) empty match boxes (ii) cartons (iii) tins (iv) cans (v) bottle covers (vi) string (vii) measured sticks (viii) old calendars (ix) plastic ball (x) cardboard e.tc.

All these are to be assembled at a safe corner, if possible appoint a member of the class that will be acting as an overseer over the items. The teacher will discover that he will not be in want when such items are needed to teach any topic in mathematics.

(b) Moulding: Waste papers, students pick as litter each day could be transformed into valuable instructional materials. Steps for moulding solid shapes are:

(i) Teacher makes available a plastic water pot
(ii) teacher instructs students to gather waste white papers.
(iii) the waste papers should be properly packed into the water pot
(iv) little quantity of water that will soak the paper should be poured into the pot.
(v) soaking should take 4 to 5 days to form mould.
(vi) hollow containers of different shapes should be provided by both teachers and students and filled with the mould.
(vii) the hollow containers should be removed to allow the solid shapes to dry. Through this process, solids such as, cylinder, triangular and rectangular pyramids, prism could be made.

Note (i) wet clay could also be used for moulding but not as neat as soaked papers.
(ii) moulding could be a whole mathematics period activities and the shapes produced by the pupils must be scored.
(iii) little starch can be added to the mould to make it sticky.

c) Modification and/or adoption of Materials: A teacher can modify and/or adopt a material depending on what the material is needed for. Modification entails removing or adding a feature or features to the original material with the intention of using it for a special purpose (mathematics teaching) other than the purpose for which it was meant to serve. For example, a teacher can cut out different plane shapes such as circle, rectangle, square e.t.c from an old calendar.

(d) Cutting of Wall and Flip Charts and Photographic prints: Old calendars that carry relevant pictures (tin, sphere, distance between objects) can be removed and used to teach various concept in Mathematics.

(e) Construction: Wood, plastics, and other construction items can be used to construct basic (2 or 3-dimensional) shapes such as rectangle, polygons, triangles, cube, cylinder, etc.

(f) Use of Modern Information and Communication Technology (ICT): Slides, tapes, films, filmstrips, television, video, multimedia (computer/software, handset) can be used to facilitate learning. Power point presentation can also be used to present charts, realia (real objects) photograph e.t.c during teaching if they are found necessary to promote effective learning. Websites that can offer help to Mathematics teachers are hereby also presented:

MegaMath presents important mathematical ideas and allows students and teachers to experience math in ways that it is experienced by mathematicians and scientists. Through fun activities and... (Multiple Agencies)

Helping Your Child Learn Math features dozens of fun activities parents can use to help children (K-5th grade) have fun learning geometry, algebra, measurement, statistics, probability and other important... (Department of Education)

Figure This! offers interactive math problems families can use to help children understand estimation, volume, and other important mathematical concepts... (Multiple Agencies)

MathTools offers hundreds of online tools, lesson plans, and learning activities for teaching and learning math—currently for grades 2 and 7 and precalculus. Tools are offered for studying... (MathForum, supported by National Science Foundation)

Exploratorium Online features dozens of online learning activities and exhibits. Make a mold terrarium, pinhole projector, telescope, or hair hygrometer. Explore the brain, biodiversity, Antarctica, DNA... (National Science Foundation)

MathDL provides Java applets, interactive modules, and Flash presentations for studying numerical and graphical solutions of differential equations, parametric representations of curves, the... (The Mathematics Association of America, supported by National Science Foundation)

Mathematics Across the Curriculum features an "electronic bookshelf" of materials for teaching math in art, history, literature, and music, as well as science, engineering, and other disciplines traditionally... (MATC Dartmouth College, supported by National Science Foundation)

National Science Digital Library provides access to resources in science, technology, engineering, and mathematics education and research. From video clips teaching cell division to simulations demonstrating plate... (National Science Foundation)

Collected Learning Units in Mathematics provides more than 200 instructional units in arithmetic, algebra, calculus, data analysis, fractions, geometry, number theory, pre-algebra, pre-calculus, probability, statistics, and... (National Security Agency)

National Library of Virtual Manipulative provides interactive online math lessons, activities, and assessments. Topics include fractions, functions, geometric transformations, integer arithmetic, patterns and sequences... (Utah State University, supported by National Science Foundation)

InterMath is designed to help middle school teachers deepen their understanding of math concepts. More than 200 "recommended investigations" are offered for teachers to solve and then modify... (University of Georgia, supported by National Science Foundation)

Journal of Online Mathematics and its Applications offers articles, learning modules, "mathlets" (single-purpose learning tools), reviews of online resources, and a developers' area. Search contents of the journal by type of resource... (Mathematical Association of America, supported by National Science Foundation)

Teacher Workshops: Math provides materials from 2007 summer teacher workshops sponsored by the U.S. Department of Education. Find slides and handouts on teaching algebra, algorithms, computation, data... (Department of Education)

Math Forum provides high-quality math education content. The site features a problem of the week for students in grades 3-12, collections of math resources grouped by subject and grade level... (Drexel University, supported by National Science Foundation)

Balanced Assessment offers over 300 mathematics assessment tasks for grades K-12. Topics and activities include averages, addition, area, batting orders, bicycle rides, chance of rain, chance of... (The Concord Consortium, supported by National Science Foundation)

SimCalc uses advanced simulation technology to help elementary students learn the concepts of "mathematics of change": problems involving rates, accumulation, approximations, and limits that... (National Science Foundation)

It is impossible to itemise all the procedures teachers should follow to improvise instructional materials. The most important thing is innovation. Lesson plan should include relevant instructional materials.

The Uses of Instructional Materials for Effective Teaching

There are basically four major steps in integrating instructional resources to enhance effective teaching.

(1) Preparation of Teacher

Mathematics teacher should get prepared to use instructional materials effectively. He/she Should,

- include the use of instructional materials in lesson plan and indicate when to introduce each of them.

- assess how the instructional materials can help in achieving set objectives.
- prepare the instructional materials and test them before the commencement of the lesson.

(2) Preparation of Students

The teacher should:

- explain to the pupils why these particular instructional materials are used.
- relate the instructional materials to a specific concept during mathematics lesson.
- define new words that are associated to the materials.

(3) Preparation for the Actual Integration of the Instructional Materials

The teacher should:

- apply appropriately a material or set of materials at the following stages (i) introductory stage (ii) content presentation stage and (iii) summary stage.
- discuss the presentation of each stage in detail.

(4) Preparation of follow-up Activities

The teacher also should also:

- ask questions that have direct bearing to the instructional materials presented.
- allow the students to respond freely at every stage of the lesson.
- evaluate the relevance of the instructional materials used during the lesson based on the set objectives.

Conclusion

Improvisation of instructional materials goes beyond the duty of only mathematics teachers. The activities enhance also, students' improvisation skills, it gives them opportunities to improvise on their own. They will like it, and their parents will have fun seeing and hearing their children create their own mathematics improvised equipment. Learning to improvise is a process that should begin coincidentally with mathematics teaching. Students should be encouraged to perform their improvisations and find enjoyment in creating their own mathematics improvised materials. Mathematics is an important subject every student must effectively learn. Every teacher therefore should go to the classrooms to teach mathematics using relevant improvised instructional materials that enhance effectiveness.

Recommendations

The following recommendations are hereby made to teachers and other stakeholders in the business of education.

1. Mathematics teachers should take improvisation of instructional materials as part of their responsibilities instead of over dependence on materials that are alien to the environment of the learners.
2. Fund for improvisation of instructional materials should be made

available to teachers since the salary they receive is relatively meagre

3. Aside capacity building on methodology and subject content, supportive training on instructional materials improvisation skills should be organized for mathematics teachers by the school owners-government and private
4. Teachers should make periodic review of instructional materials they use especially now that the curricula are being changed from time to time
5. Teachers should involve learners too in the business of improvisation of instructional materials, to make more meaning to them when they are used.
6. School managers, supervisors and inspectors should equally be trained on how to evaluate the adequacy of instructional materials used by teachers during teaching.

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