IOSR Journal Of Humanities And Social Science (IOSR-JHSS)
Volume 23, Issue 6, Ver. 1 (June. 2018) PP 54-61
e-ISSN: 2279-0837, p-ISSN: 2279-0845.
www.iosrjournals.org

Towards Making Primary Mathematics Lessons Child-Centred and Relevance: The 'Why' and 'How' of Four-Step Experienced-Based Strategy (FES_4)

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Abstract: *The significance of Mathematics to the development of human reasoning and the entire society has been informing several research studies and interventions aimed at demystifying the poor academic attainment in the subject at the primary education level. The major focus of research studies and interventions at primary education level is the understanding of the instructional methods and/or strategies that teachers adopt when teaching Mathematics. This has brought about many notable changes in how young children are exposed to the teaching and learning of the subject. Child-centred strategies such as those pivoted on both cognitive and social constructivism are products of these interventions. However, it has been observed that the current child-centred strategies fail to take into consideration, the experience of the learners. This appears to make the newly learnt mathematical activities strange ones to the learners while limiting the extent to which the learners perform the activities. This has made imperative the need to link the child-centred strategies to the familiar experiences of the learners. Hence, the Four-step Experience-based Strategy (FES_4). This paper discusses the features of FES_4 and presents the format for a lesson plan congruent with the FES_4. The strengths of the FES_4 in demystifying Mathematics learning while making mathematical skills functional to the everyday lives of the learners have been highlighted. The paper concludes that FES_4 is a viable alternative for effective teaching and learning of Mathematics as a primary school subject.*

Keywords: Primary mathematics, instructional strategy, FES_4, mathematical skills, pupils' learning.

Date of Submission: 20-05-2018 Date of acceptance: 04-06-2018

I. INTRODUCTION

The content of Mathematics at all levels of education particularly preschool and primary education is capable of inculcating knowledge, skills and procedures that can be used in a variety of human activities such as describing, illustrating, interpreting, reasoning and most importantly problem solving. Because of this versatility nature of Mathematics to develop human being, it was made a compulsory subject at early and foundation level of education. Omenka and Otor (2015) opine that the qualities and characteristics of Mathematics make it to be regarded as an essential tool for the child in understanding the world around him or her. Mathematics do more than developing individual child, but also affected the entire society in the advancement in science and technologicaland it application to several and varied human endeavours (Inyang 2005). To this end all efforts must be put in place to improve the learning of the subject most especially in the developing countries such as those in Africa.

The process of exposing mathematics to the learners, known as mathematics education is expected not only to equip the learners with knowledge of quantitative but to improve the learner's attitude and application of mathematical reasoning in their everyday activities. This might be the thinking of Otunu-Ogbisi (2009) who explains that mathematical instructions is the act of imparting and acquiring skills, knowledge, aptitude, abilities and attitude capable of making the individual functional and productive towards the achievement of nation‘s developmental goals. To illustrate the purpose of Mathematics, Odumosu et al. (2012) liking mathematics to the carpenter‘s hammer, tailor‘s tape, artist‘s pencil, barber‘s clipper, hair dresser‘s comb, journalist‘s pen, broadcaster‘s microphone, doctor‘s stethoscope and lawyer‘s wig. In other words, Mathematics is a tool to solve societal problem and should not be seen as the problem itself. That is why the instruction must be presented such that it can inculcate in the learners, thinking skills and reflections on self, environmental and societal issues that can be quantified and so also to be able to organise one‘s experiences for possible solution(s) to problems. To support this argument, National Science Foundation (2002) submits that in order for learners to acquire the conceptual understanding of Mathematics in different ways, they have to know how and when these different mathematical representations can be used for different purposes. Such presentation could enable the learners experience, discover, discuss and reconstruct the socially negotiated nature of Mathematics. On this basis, considerable efforts must be placed on the pedagogical aspect of mathematics education most especially at the early stage of education, preschool and primary levels to be precise.

Performance in primary mathematics in some selected countries in Africa

Performance of children in preschool level as revealed in end-of-year reports and observed by Hagoramagara (2015), Omenka andOtor (2015) as well as that of Simba et al. (2016) show that there seems no significant problem with the learning of number work at that level. Children seem not having challenges learning the important skills related to Mathematics their performance in number work at that level is as good as their performances in other subject areas.

It was reported by Bosire, Mondoh and Barmao (2008) that performance in Mathematics in Kenya is nothing to write home about. The learning of this important subject was so poor in this country that only 15% of students who enrolled for mathematics examination in Kenya scored grade D+ (30-40%). Mbugua et al. (2012) reported a study of trend in performance in Mathematics for the period of 10 years in Kenya Certificate of Secondary Education Examination between which was between the year 1999 and 2008. The study shows that the national mean scores range from 12.23 to 18.73 (Mbugua et al. 2012).The recent work of Karigi and Tumuti (2015) shows that the poor performance of learners in Mathematics in Kenya is still persisting.

In Nigeria, national assessment of pupils performance in mathematics were conducted in the year 2004 and 2009 by Nigeria Education Sector Analysis (ESA) and National Assessment of the Universal Basic Education Programme (NAUBEP) respectively. The two assessments revealed not only that pupils' performance in Mathematics is below average but also that the problem solving skills of the pupils is poor. ESA Report(2004) shows that the national mean scores of primary four and six pupils in numeracy are put at 33.7 and 35.7 respectively. The NAUBEP Report (2009) shows that the national mean score is 42.87% which is below average. It further shows that only three states out of the thirty-six states and the Federal Capital Territory have scores that is up to average- Jigawa State (mean = 58.26%), Bayelsa State (Mean = 55.96%) and Osun State (mean = 54%). Fifteen states have mean scores that is not up to pass mark (40%). Their scores range from 23.35% for Kano State to 29.23% for Ondo state. A study in the year 2014 by Sa'ad, Adamu and Sadiq shows that performance in Mathematics is still very poor because those that passed the subject in national examinations in the study year ranges from 26% to 32% (Sa'ad et. at. 2014).

Siyepu (2013) declares that the performance of learners in Mathematics in South Africa is at a shocking state. It was also reported that the learners performance in mathematics in the Annual National Assessment for Grade 9 in the year 2012 revealed that 0.2% of thoseenrolled for the examination scored 80% and above; 0.3% scored between 70 – 79%; 0.6% scored between 60-69%; 1.1% scored between 50-59%; 2.1% scored between 40-49%; 3.8% scored between 30-39% and 91.9% scored less than 30% (McCarthy & Oliphant 2013). With a simple arithmetic, this implies that only 2.2% of the total learners that sat for the mathematics examination scored above 50%. Department of Education (2014) also reported that the average score for Annual National Assessment of Mathematics in Grade 4 in the years 2014 is 20%. All these show that mathematics learning in South Africa too is as poor as reflect in other African countries. Ngwareet. al. (2015) support this notion by submitting that African countries performance in Mathematics appears much poorer than elsewhere in the world. The argument was buttressed by citing the instance of those five countries that participated in the International Mathematics and Science competition and were ranked among the last seven of the 45 countries that took part in the year 2003.

Instructional methods/strategies adopted in teaching primary mathematics and their theoretical background

There are several methods and strategies that are available for teaching and the theoretical backgrounds to these methods/strategies are also many. But two common methods mostly adopted by primary mathematics teachers in Nigeria in particular and Africa in general will be examined alongside their theoretical background. The first and most commonly adopted method (Though some teachers do fortified with some strategies like question and answer, advanced organiser, use of resources and so on) is direct instruction (DI). In Nigeria for instance, other names given to this method is either chalk-and-talk or conventional method. DI is a teacher centred method of teaching in which the teacher is the one giving new information, procedure or skills to the learner.Klahr and Nigan (2004) submit that DI has been proven to be efficient way to teach procedures that are difficult for students to discover on their own and further cite examples of such topics in mathematics as geometry and algebra. Bonner (2012) describes DI as an instructional approach in which the teacher structures lessons in a straightforward, sequential manner.In this approach, the teacher is clearly in control of the content or skill to be learned and the pace and rhythm of the lesson.

While some literature claim that DI is not effective in teaching (Alliance for Childhood 2000; Schauble 1996; Stohr-Hunt 1996); some also are in support of it as an effective strategy for teaching procedural knowledge such as the ones in mathematics (Bonner 2012; Klahr&Nigan 2004; Rosenshine& Stevens 1986).

DI is a teaching method that rest on an educational theory known as behaviourism. The behaviourists are of the view that learners are capable of responding to stimuli and hence experience behavioural change which is known as learning (Fantino, Stolarz-Fantino& Navarro 2003). This theory presents teaching as a process of using shaping behaviour through the use of motivational strategies such as positive, negative and/or non-reinforcement and punishment.

In classroom teaching context, the planned lesson is carefully delivered so as to serve as effective stimulus which is capable of generating pre-determined responses from the learners. The learners' responses (or behaviours) can now be shaped using motivational strategies. Most of the Mathematics lesson using this strategies used to follow common line of action starting from *giving the topic* (with some explanations), followed by *working some examples* for the learners to observe, and then *giving some exercises* to do (where the teacher either guide and/or correct the learners' works).

The general low performance in Mathematics when this method is used give concerns to educators as to the effectiveness of the method. Many scholars, most especially the constructivists argue that DI cannot produce better learning outcomes in Mathematics because learners are passive during the instructional activities. This argument and many more led to the evolvement of another theory known as constructivism and afterward the socio-constructivism also emerged. While constructivism promote such teaching strategies that engage the learners in *doing* during the instructional activities socio-constructivism added that constructivist strategies will be more effective when the instructional activities involve group of people most especially a more experienced person that can scaffold the learning in the activities (Excell, Linington& Schaik 2015). Instructional strategies adopted by primary mathematics teachers based on these theories are child-centred and some of them are activity-based, exploratory, hands-on, guided discovery among others.

Many schools in many African countries have been using these strategies for decades now but significant improvement in the mathematics learning outcomes seems not forthcoming. Therefore, this make one wonder if something is still missing in the process of using these child-centres, activity-based strategies.

It is on this premises that the thought of the state of *entry behaviour* or *prior knowledge* in the process of using any of the child-centred strategies is been considered. Maheshwari (2017) describe entry behaviour as what the learner has previously learned, his intellectual ability and development, his motivational state and certain social and cultural determinants of his learning ability which are relevant to the learning task. It was further explained that when determining entry behaviour of learner, the ability, experience, skills and interest should be factored in. The major reason for respecting and factoring in entry behaviour in a lesson is to advance the learner from where he is (Entry behaviour) to where the teacher would like him to be (Objectives of the lesson or terminal behaviour) (Maheshwari 2017).

The questions begging for answers now are, to what extent does entry behaviour/prior knowledge is been considered when activity-based lesson is been plan or delivered in primary mathematics? Is the entry behaviour/prior knowledge in activity-based mathematics lesson related to real life experience of the learners? To what extent is the concept of entry behaviour/prior knowledge covered in the constructivism and socio-constructivism? What is the position of constructivism and socio-constructivism on how entry behaviour/prior knowledge be used in a child-centred lesson?

The views of major proponents of behaviourism about learning are summarised by Speaks (2016) thus:

John Watson: *Instead, he believed that people's reactions in various situations were determined by how their overall experiences had programmed them to react.*

Ivan Petrovich Pavlov: *Pavlov was able to condition, or teach, these dogs to salivate in unnatural situations (after hearing a sound) to stimuli which would normally not ellicit that response (sound). Human behaviour is based on stimulus – response relationship (conditioning).*

Edward Thorndike: *The repetition of a response strengthens it and behaviors were either strengthened or weakened, depending on whether they were rewarded or punished (Instrumental conditioning).*

B.F. Skinner: *It wasn't what comes before a behavior that influences it, but rather what comes directly after it (Operant conditioning).*

Of all the views of these scholars on behavioural change, it was that of Watson that recognises entry behaviour/prior knowledge in the process of acquisition of knowledge. Watson believes that whatever ones experience could be, it can be changed through conditioning (Albert and the white rats experiment). The implication of this is that in behaviourism, already acquired experience matter less in the acquisition of new knowledge but the power of the conditioning (teaching, in the education context) used.

Constructivism deviates from the position of behaviourism in that it presents the human as active learner. Bhattacharya and Han (2001) explain the view of the major proponent of cognitive constructivism – Jean Piaget – thus:

Human beings possess mental structures that assimilate external events, and convert them to fit their mental structures. Moreover, mental structures accommodate themselves to new, unusual, and constantly changing aspects of the external environment.

In the other hand, social constructivism position human as social being who learn is a social setting. Galloway (2001) put the position of Vygotsky thus:

When a student is at the Zone of Proximal Development *(ZPD) for a particular task, providing the appropriate assistance (scaffolding by More Knowledgeable Other {MKO}) will give the student enough of a "boost" to achieve the task. Once the student, with the benefit of scaffolding, masters the task, the scaffolding can then be removed and the student will then be able to complete the task again on his own.*

From these two positions, cognitive constructivism respect entry behaviour/prior knowledge in the process of acquiring new knowledge. The existing mental structure which gives room for accommodation is formed by the experiences earlier acquired.

Because of this position, any good activity-based lesson plan format usually gives room for the identification of entry behaviour/prior knowledge. The concern of this paper is on how the entry behaviour/prior knowledge is being used in teaching/learning process. Most of the time, what mathematics teachers do is to identify the related entry behaviour to the new knowledge to be delivered, during lesson delivery ask the learners about the entry behaviour and if satisfied with the responses, deliver the new knowledge. But few questions can be asked here, what type of entry behaviour could assist the learners in mathematics learning, real life experiences or previously learnt mathematics topic? If real-life experience is identified as entry behaviour, how do mathematics teachers ensure that the learners can relate the new topic to such entry behaviour? If the learners are unable to relate the new topic to real life experience, can knowledge acquired in such mathematics lesson be applied to real life situation or problem?

Four-step experienced-based strategy (FES_4)

Four-step experienced-based strategy (FES_4) is an instructional strategy specifically developed for primary mathematics lessons by a university lecturer who specialises in Early Childhood Education/Mathematics. FES_4 is based on the premise that primary school pupils will learn mathematics effectively (higher score, positive attitude and more interest) if their related real-life experiencesare reproduced, build on and used as reinforcement in all mathematics lessons. To this mathematics instructional strategy, *related real-life experience* means those activities or situations the pupils are familiar with in their everyday life. The term *experience* is used because it does not mean what the pupils have learnt previously in the classroom, rather it means what they used to do or situations they have experiencesabout which are directly related to the new mathematics to be delivered by the teacher.

FES_4 is different from other child-centred instructional strategies because of its emphasis on the related real-life experience of the learners in the process of teaching them Mathematics concepts. Unlike other strategies where the entry behaviour/prior knowledge is been identified and the new lesson is built on it; FES_4 identifies the entry behaviour (The real life experience), recall the experience/skills in the classroom, presents the new mathematics topic related to the experience and gives class exercises and home works in the context of real-life experiences. It is believed that the real-life experiences of the learners which are being used as the platform to present the mathematical concepts; are coming from the day-to-day activities and experiences in the immediate community. This will enable the contextualisation of the mathematics topics and enable the learners to relate every Mathematics topics to their real-life experiences.

The argument of FES_4 as a primary mathematics instructional strategy is that, with the way the subject is been taught now, learners are unable to relate it to their everyday life which might be the reason majority of the learners not being motivated to put effort in learning and hence account for the mass failure recorded in the subject. If primary mathematics teachers can assist the learners to recognise where these mathematics topics are needed in their everyday life activities by invoking the experiences in the classroom, build the new mathematics topic on it in a child-centred method, scaffolding the newly learnt knowledge or skills and reinforcing the consolidation of the knowledge or skills through real-life experiences; there ought to be a better learning outcomes (in terms of attitude, interest and academic performance) in the subject.

Theoretical Background to FES_4

FES_4 is based on cognitive constructivism propounded by Jean Piaget. According to Bhattacharya and Han (2001), cognitive constructivist is of the view that human being possess mental structure that assimilate external events (New knowledge) and restructure them to fit into their mental structure (Already acquired experience). Moreover, the mental structure accommodates the new, unusual and constantly changing aspects of the external environment (Ready to learn new things always). In other words, learners construct their understanding of their environment (Learning or real life situations) in an attempt to organise, understand and adapt to it through three continuously interacting processes of assimilation, accommodation and equilibration (Excell et. at. 2015).Assimilation has to do with how the learner come in contact with the new knowledge in terms of existing schemas or operation and the quality of assimilation tends to influence the next stage which is accommodation. The process of changing the already formed experience or knowledge to provide room for the new ones is what is referred to as accommodation while the internal attempt to make sense of the new knowledge or experience by striking balance between assimilation and accommodation is the equilibration stage (Bhattacharya and Han 2001).

In order to make assimilation process strong enough so as to influence accommodation and then bring about desirable equilibration, Piaget suggested active exploration of the environment by the learner (Excell et. at. 2015). It is on this basis that constructivist strategies emphasis 'do' on the part of the learners which is believe to enhance how the construct their knowledge. The position of FES_4 is that primary mathematics teachers have to take the responsibility of assisting the learners to associate the 'do' with the existing experience so as to enhance and consolidate their equilibration. It is observed that many of the constructivist instructional strategies emphasises 'do' but take less cognisance and underutilise the existing experiences of the learners in the process of giving stimuli for assimilation. This is the gap the new strategy - FES_4 – tries to bridge.

Features and procedure of four-step experienced-based strategy (FES_4)

Just like other instructional methods and strategies, FES_4 has its own unique procedure and what to be featured at every step of the procedure. In this section, attempt is made to present the steps, what each of the steps means and what are the expected features of each step. As the name suggests, the strategy has four steps namely:

Step 1: Recall pupils' related experience to the new topic.
Step 2: Allowing pupils to do the experience.
Step 3: Exposing the Mathematics concept in the experience.
Step 4: Challenging the pupils through their experiences.

Step 1, Recall pupils' related experience to the new topic: It is believed that all topics in primary Mathematics are related to a given real-life activity or situation. In teaching any particular Mathematics topic adopting FES_4, the first step is to invoke the related real-life experience(s) of the learners in the class. If this is appropriately done, it is expected to serve many purposes such as being the introduction, establishing the entry behaviour and serve as advanced organiser all at the same time. The onus is on the teacher to identify the common and the most related real-life experience to choose out of numerous that might be suggested by the learners. Also, the teacher must think about amount of time to be spent of 'doing' the experience. This calls for the teacher's pedagogical skills, particularly the skills of power (Selecting the most important information to be given) and economy (Giving few but most important facts) in lesson delivery.

Step 2, Allowing pupils to do the experience: As soon as the most related real-life experience is chosen (From step 1), the teacher is not expected to assume that all the pupils have the experience or the skills needed in the chosen real-life activity or situation.Therefore, the teacher encourage the pupils (Individually or collectively, depends on the task) to carry out the experience in the class (Do). This step will assist the teacher to identify where the individual pupil is as far as the identified real-life experience is concerned. Any child seeing not being at the same level of the experience will have the opportunity to gain such while observing his/her peers. Step 2 has several advantages some of which are to create fun environment for pupils to learn 'abstract' subject; make the pupils active in the process of acquiring mathematics knowledge; constructing a real-life space for the new mathematics knowledge to be acquired and giving mathematics teacher a solid foundation to build a new knowledge. During this activities, the teacher should be observant and be looking for a good 'teachable moment' when the new mathematics topic could be injected into the pupils' activities. This is expected to give way to the next step.

Step 3, Exposing the Mathematics concept (To-be delivered) in the experience: At this stage, the teacher is expected to take charge of the classroom activities by first, bring out the new mathematics topic out of the pupils activities, do a kind of scaffolding by demonstrating the mathematics operations the pupils need to learn and what the figures/symbols are representing in the real-life experience. This step should be crowned with working of examples of the mathematics operation with adequate involvement of the pupils (questioning strategy is expected to assist at this point). The success of Step 3 is measured by two important behaviours of the pupils. The first is ability to perform the mathematics operation(s) learnt while the second is ability to relate the mathematics concept to real-life situation. If this step is successful, then the teacher is expected to go to the next step.

Step 4, Challenge the pupils through their experiences: Step 4 in FES_4 serves two important purposes in primary mathematics lesson delivery. The first is to assess the extent to which the behavioural objectives of the lesson have been achieved. In order to get this done, the teacher is expected to give some class exercises to the pupils and adopt a method of marking and giving feedbacks to the pupils. Two things can happen as far as achievement of the objectives is concerned; the extent of achievement of the objectives might be low which tells the teacher to check the entry behaviour (real-life experience adopted), the procedure/resources used and examples given to the pupil and decide how the lesson will be repeated. If the achievement of the objectives is high then the teacher will move to the second purpose of the step which is to reinforce the mathematical knowledge/skills acquired. This is achieved by given few important home works which must be based on real-life experience from which the topic was derived. The success of Step 4 and in most cases, of the lesson is measured if the exercises and the home works are capable of improving on the real-life experience the pupils came to the class with.

Based on these features of FES_4, a lesson plan format was developed and this is as presented in the next page.

FES_4 LESSON PLAN FORMAT

Class: ……………………

Age bracket: ………………

Topic: …………………

Sub-topic: ………………

Duration: ………………

Behavioural objective (*At least 2 of the 3 learning domains*): By the end of the lesson, pupils should be able to:

1. ……………………………………
2. ……………………………………
3. ……………………………………

Presentation

Stages	Teacher's Activities	Pupils' Activities	Possible Questions
Stage 1: (*Recall*) *Duration* *3-5mins*	*Ask the pupils about the real-life experience related to the sub-topic:*	*Pupils share their real-life experiences:*	*Teacher list possible questions that should be asked:*
Stage 2: *(Demo of experience)*	a. *Ask the pupils to demonstrate the real life experience:* b. *Identify the teachable moment*	*Pupils do (in a fun-filled environment):*	*Possible questions:*
Stage 3: *Deliver the new lesson*	*Teach the new topic with adequate examples (Carry pupils along with questions):*	*Pupils answer the questions and observe the examples:*	*Possible questions:*
Stage 4 *(Reinforcement)* *And* *Evaluation*	a. *Give few class activities:* b. *Mark and give feedback* c. Give home works:	a. *Pupils do the exercises:* b. *Pupils take the home works:*	

Conclusion: *(Not more than 3 sentences to explain what the pupils have learnt (This can be put in questions too):*

……………………………………………………………………………………………………

……………………………………………………………………

Teacher's Remark: Is the lesson delivered? Yes ( ) No ( )

Is the lesson successful? Yes ( ) No ( )

What Next? (Choose one) Repeat the modified lesson ( ) Do differentiated lesson to some pupils ( ) plan the next topic/sub-topic ( )

Strengths of FES_4 as an instructional strategy for primary Mathematics

FES_4 shares all the strengths of any other instructional strategies that is based on constructivism such as making learners active in the teaching/learning process, highly effective for learners with tactile learning style, enhance the ability of the learners to relate what is learnt to their lives, encourage group activities and hence promote the development of social skills (Roberts n.d.). Other benefits include giving learners the opportunity to acquire more knowledge not planned for by the teacher; give learners room to be in-charge of their learning in terms of pace and rhythm; promote higher order thinking; give room for differentiated teaching; enhance better retention of learned skills and knowledge; learners become confident in the knowledge and skills and development of problem-solving skills.

In addition to all these, it is believed that FES_4 makes learning of Mathematics to be fun-filled. This will happen when pupils are asked to demonstrate their familiar real-life activities and plays in the classroom. This reduces the tension that normally permeates mathematics learning environment. Again, it is expected to enhance the learners' ability to apply mathematics concepts to their real-life activities, problem solving and situations more than other constructivism strategies. This will happen because FES_4 makes pupils see new mathematics knowledge coming out of their real-life activities and when the knowledge is learnt, it enables them to use it in real-life situations. Most importantly, FES_4 will contextualise all mathematics concepts to the immediate environment of the learners. The learners will be able to identify what kind of their daily activities is associated with what mathematics concept.

II. CONCLUSION

In as much as learning of Mathematics has not been at a state of satisfaction in the society generally, the evolution of instructional strategies that can demystify the acquisition of mathematics knowledge and skills is far from being concluded. FES_4 as a new instructional strategy based on cognitive constructivism is specifically developed to make learning of mathematics fun-filled, related to real-life activities of the pupils and to bring about better learning outcomes.Therefore, FES_4 is a viable alternative for effective teaching and learning of Mathematics as a primary school subject.

RECOMMENDATIONS

The following recommendations are proffered in other to ensure that primary mathematics teachers adopt FES_4 appropriately so as to experience improvement in the learning outcomes of pupils in the subject:

- There is the need for mathematics education researchers to establish the effectiveness of FES_4 in their respective areas in Africa through quasi-experimental research studies. This will validate the strategy in that environment and also see to its wider adoption.
- As a short time recommendation, mathematics teacher trainers should be trained on the use of FES_4 so that they would be able to educate the in-service and pre-service teachers in their jurisdictions. Government, through Ministry/Department of Education and NGOs are expected to take the organisation and administration of such training across African countries.

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