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Review

Enhancing Quality of Mathematics offered in the Nigerian School System; through effective Mathematics Professional Development

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This paper focuses on enhancing quality of mathematics offered in Nigerian School System; Through effective mathematics professional development.The poor performances of students in mathematics at both internal and external Examinations in Nigeria, are of great concern to all Educational Stakeholder's. In quest of looking for how to improve teacher's content knowledge in mathematics, improve their skills and instructional practices at the classroom, inform this study. Hence this paper sought to examine and review relevance literatures on the four core goals area and features of mathematics professional development, as to ascertain the extend at which it will improves teacher's content knowledge/practice via students high achievement. The examined and reviewed literatures shown among others that changes which occurred in teacher knowledge/practice, increase in students learning and achievement are all as a result of effective mathematics professional development. It was recommended that this review should serve as a guiding document among others, for mathematics educators in Nigeria as they plan professional development.

Keywords: Enhancing, Quality of Mathematics, Offered, Professional Development, Nigerian and school system.

INTRODUCTION

Mathematics is one of the core courses in Nigerian school system. Studies have shown that the model of instruction especially at the secondary school level remains overwhelmingly teacher-centered with greater emphasis on the lecture mode of instruction and the use of textbook than engaging students in critical thinking across subject area and applying the knowledge acquired to real-world situations (Butty, 2001).The teacher is the most indispensable factor in effective administration of any education system. Also it has been established that no amount of resources put into the Nigerian school system without adequately prepared and motivated teachers, nothing tangible can ever be achieved from the system. The role of teachers at all levels of education is emphasized in the National Policy on Education (FRN, 2004), that no educational system may rise above the quality of its teachers. This declaration in the policy document underscores the need for teachers effectiveness in teaching and learning.

In appreciation of the importance of Mathematics and its relevance to national development, the National Policy of Education (FRN, 2004), emphasizes on the need for basic knowledge and application of mathematics in science and technology for purposeful and meaningful development .The policy also reflects that the teaching of problem solving in the classroom is very essential in

order to prepare the students for problem solving challenges outside the four walls of the classroom. Effectiveness of classroom instruction originates from the teacher. If the teacher is well prepared, well-versed and thoroughly supported, then changes in the curriculum and instructional strategies can occur. Confidence is a source for teachers to accept and test different instructional strategies. In mathematics education, using various strategies to motivate students to learn mathematics concepts is important.

Despair the unique position accorded Mathematics in the National Policy of Education, it is painful to observed that mathematics often recorded dismal performances of students at both internal and external examinations at all levels of our educational system. The quality of teaching and learning mathematics in our schools system is a major challenge for the Nation mathematics educators. Hence this paper sought to scan relevance literatures to examine the role the four core goals of mathematics professional development play in improving students' learning through the mechanism of improving instruction.

The role of teachers as the most important factor in students' achievement have been growing recognition in recent years (Carey, 2004; Haycock,1998).Support for this perspective comes from a landmark study on teachers quality in Tennessee. Sanders and Rivers (1996) used student achievement data for all teachers across the state of Tennessee to determine how "effective" teachers were, then tested and followed specific students over several years. They found that students who performed equally well in second grade, but had different teachers over the next 3 years, performed unequally by year 5.

Fifth grades who had "effective" teachers in third, fourth, and fifth grades scored in the 83rd percentile in Grade 5, but those students' who studied in the third, fourth, and fifth grades under the "ineffective" teachers, scored much lower (the 29th percentile, 54-point differences) by the end of fifth grade.

Similarly, Sanders and Rivers founds that in 1 year, the most effective teachers could boost the scores of their low-achieving students an average of 39 percentile points compared to similar low-achieving students' who had ineffective teachers. For example, one analysis (Darling–Hammond and Youngs, 2002). Found that the formal preparation of the teacher (Specifically, certification and subject-matter degree) predicts higher students' achievement. Teachers' cognitive and verbal ability and knowledge of subject matter are not as important to students' achievement as teacher's completion of a formal degree in the subject matter and pedagogical knowledge. However, another analysis proposed that cognitive and verbal ability and content knowledge are more important than certification or a master degree (U.S Department of Education, 2002).

Yet other analysis propose that it is not individual teachers but the alignment of content standards, curriculum tied to those content standards, teachers trained to use that curriculum, and accountability that leads to students' achievement (Whitehurst, 2002). Other research has supported the notion that specific models of instruction, see (e.g., success for all, see Borman and Hewes, 2002). Regardless of whether it is the teacher's background and qualifications, teaching methodologies, or alignment of standards with curriculum and accountability that leads to student success, each of these depends on effective training and preparation of teachers.

Statement of the problem

The poor performance of students in Mathematics both internal and external examinations in Nigeria is of a great concern to the government, parents and well meaning Nigerians. It has been observed that the huge investment on education is not yielding the desired dividend (Adebule, 2004). The teachers also complained of students' low performance at both internal and external examinations (Ashiaka, 2010). It has been observed that the annual senior school certificate examination for the last six years recorded the highest percentage (57.26%) credit pass in Mathematics in 2008. Since changes in teacher knowledge/practice and increase in students learning and achievement have been linked to professional development. Hence this paper sought to review relevance literatures to examine the four core goals and features of effective mathematics professional development, and to ascertain the extend at which it will improve teachers' skills, develop their mathematical content knowledge and improves their classroom instructional strategies, via students higher performances. We intend this paper to guide mathematics educators in Nigeria, as they plan professional development.

Research questions

The research questions this review sought to answer is among others;

Does the four core goals and features of effective mathematics professional development improves teachers' content knowledge, instructional practices at the classroom, via increase students learning and high achievement in mathematics?

What are effective mathematics professional developments?

DISCUSSION

Core goals and features of mathematics professional development

The long-term goal of improving students learning through better instruction, research evidence to date suggests that professional development we promote the growth of mathematic teachers in four major areas.

Build teachers' mathematical knowledge and their capacity to use it in practice

Teachers' mathematical knowledge matters and significantly predicts gains in students' achievement (Hill, Rowan and Ball, 2005; Jacobs et al., 2007). In order to enact instruction that supports students' learning, teachers need mathematical knowledge that extends beyond an understanding of mathematical procedures and concepts (Kilpatrick, Swafford and Findell, 2001). Teachers must be able to choose appropriate Mathematical tasks, judge the advantages of particular representations of mathematical concepts, help students make connections among mathematical ideas, and grasp and respond to students' mathematical arguments and solutions. A lack of mathematical context knowledge can impede teachers' abilities to notice and analyze students' mathematical thinking (Doerr and English, 2006), design actions that respond to students' understanding. Research has found that professional development that attends to dimensions of teachers' mathematical knowledge is more effective than professional development that focuses only on pedagogy or generic teaching skills (Garet et al., 2001; Heck et al., 2008).

Research also indicates that teachers can develop their mathematical content knowledge in a number of different ways, including solving and discussing mathematics problems, studying students' mathematical thinking, collaborating with other teachers to plan or discuss instruction, analyzing instances of classroom practice, and using new curricular materials (Horn, 2005; Remillard and Bryans, 2004; Perry and Hurd, 2009).

When teachers solve mathematical problems together and share solution methods, it can affect their understanding of the mathematical content and introduce new perspectives on a problem (Lachance and confrey, 2003). Teachers can also strengthen their mathematical understanding in the process of trying to make sense of students' work or analyzing instances of classroom practice (Borko et al., 2008). For example, Ticha and Hospesova (2006), report on a teacher who expanded her ability to think flexibly about subtraction by exploring a student's unexpected argument that 63-8=60-5 because the difference remains the same if both 63 and 8 are reduced by 3. Improved mathematical knowledge can also help teachers connect mathematics to classroom practice as they analyze and use new curriculum materials.

Finally, professional development that focuses on improving teachers' mathematical knowledge can help them develop the confidence to teach mathematical topic that they previously avoided (Chapin, 1994).

Build teachers' capacity to notice, analyze and respond to students' thinking

A number of studies provide evidence that professional development can help teachers learn to notice, value, and analyze students' mathematical thinking. Professional development that helps teachers attend to students' thinking can shift teachers' focus from simply evaluating students' work as correct or incorrect to analyzing the particulars of students' thinking (Borko et al., 2008; Goldsmith and Seago, 2010; Van Es and Sherin, 2008). For example, elementary school teachers participating in Cognitively Guided Instruction (CGI) professional development learned to recognize increasingly sophisticated strategies among students who correctly solved addition and subtraction problems. They also learned to make principled decisions about choosing mathematics problems that would engaged and extend each student's current level of reasoning (Fennema et al., 1996). Similarly, teachers participating in professional development based on CGI principles learned to recognize a variety of students' algebraic reasoning strategies and notice strengths in students' mathematical thinking that could be built on, even when students' solutions were not entirely correct (Jacobs et al., 2007).

Professional development that supports close attention of students' thinking may also help teachers recognize that they have tended either to overestimate (Schorr and Koellner-Clark, 2003), or underestimate their students' understanding (Kazemi and Franke, 2004; Wood and Lehman, 2005).

As teacher learns to notice and analyze students' thinking, they gain more accurate picture of the strengths and weaknesses in students' mathematical understanding (Borko et al., 2008, Chappell, 2001). Teachers can then use their analyses of students' thinking to refine instruction and to respond to students' needs (Kazemi and Franke, 2004, Seymour and Lehrer, 2006; Sherin and Han, 2004).

Build teachers' productive habits of mind

Learning to improve one's' teaching practice is challenging, effortful work. An important goal of

professional development is to help teachers develop the beliefs, habits, and dispositions needed to improve practice on an ongoing basis. For example, teachers' beliefs about mathematics (Borko, 2004), curriculum (Collopy, 2003; Remillard and Bryans, 2004), and students' capacity for learning (Wood and Leman, 2005), all influence what teachers learn from mathematics professional development opportunities. Likewise, teachers' dispositions and habits of mind, including habits of inquiry, curiosity, self-monitoring, attention to students' thinking, and experimentation influence teachers' learning from professional development opportunities (Allinder et al., 2000; Clarke and Hollingsworth, 2002).

Professional development programs themselves shape teachers' beliefs and habits of mind in a ways that influence teachers' subsequent learning from practice (Britt, Irwin and Richie, 2001; Zech et al., 2000). Hence, an important criterion for selecting a professional development program is whether it nurtures beliefs and dispositions that result in continued learning in daily practice. For example, professional development experiences in which teachers analyze instruction, live or on videotape, may help teachers shift from a descriptive or evaluative stance toward an inquiry stance toward practice (Perry and Lewis, 2010;Van Es and Sherin, 2008), and build teachers' confidence that changes in their instructional methods can improve students' learning (Perry et al., 2009).

Professional learning experiences that involves learning mathematics related to teaching can build teachers' desire to learn more mathematics, perhaps by building the sense of efficacy, identity as a mathematics learner, or collegial support for learning (Polettini, 2000; Hodgen and Askew, 2007). Given that professional development does not automatically build productive habits of mind, those responsible for professional development may want to directly address whether efficacious beliefs and habits of mind- such as inquiry into students' thinking, confidence that all students can make sense of mathematics, and interest in deepening one's own mathematical understanding- are developing.

Build collegial relationships and structures that support continued learning

One way that professional development can support teachers' ongoing learning is by catalyzing changes in collegial relationships and structures for collegial work.

Recent research has pointed to the value of collaboration for the learning of teachers. Collaboration with colleagues can speak the need for teachers to explain their practices and to articulate rationales for instructional decisions, helping teachers make tacit ideas visible and subject to shared scrutiny and develop deeper, more widely shared understanding of students' learning (Horn, 2005). Professional conversations can also provide teachers with the encouragement and support that is needed to begin to experiment with new approaches to teaching (Britt et al., 2001). Teachers value the kinds of professional relationships that can be built through shared inquiry into practice; such interactions with colleagues can support teachers' sense of competence as they engage in the work of changing practice (Arbaugh, 2003; Smylie, 1998).

However, collegial interactions do not always leave to professional learning. The emotional support that can come from sharing stories or observing in each other's classroom does not necessarily lead to a focus on improving aspects of teaching (Cwikla, 2007). When collegial interactions do focus on classroom instruction, teachers may experience a tension between colleagues' suggestions and their own sense of autonomy to decide whether and how to use ideas (Puchner and Taylor, 2006).

Several studies suggest that of the effectiveness of collegial learning structures can be built over time. For example, teachers in the study group that Kazemi and Franke (2004), were initially unaware of the details of students' problem-solving strategies and saw posing questions to understand students' ideas as unimportant, despite the facilitators' efforts to focus on students' thinking. Over time, as teachers found ways to interact with students about their strategies, and they began to share their efforts to understand students' ideas in their study group meetings. Likewise, teachers at a school-wide lesson study site showed a substantial increase in the proportion of discussion devoted to students' thinking from year one to year three of the schools' adoption of lesson study (Perry and Lewis, 2010).

Professional development features that supported why collegial structures, that support learning may develop gradually over time, rather than emerge fully developed as an immediate consequence of a professional development intervention.

Substantial Time Investment

Several large-scale studies suggest that the duration of professional development is significantly associated with impact on teachers (Heck et. al., 2008; Hill and Ball, 2004). For example, a study of summer professional development workshops ranging from 40 to 120 hours in length associated longer workshops with teachers' greater knowledge gain, although some programs were exceptions to this trend (Hill and Ball, 2004).In their evaluation of the NSF-funded local systemic change initiatives, heck and his colleagues documented a significant relationship between hours of participation and

teachers' self-reported increases in investigative classroom practices, with most of the gains occurring during the first 100 hours of professional development(Heck et al., 2008). With respect to the use of instructional materials, much of the gain occurred with the first 80 hours of professional development, with an additional increase after about 180 hours.

Qualitative studies illuminate some of the reasons that professional learning takes time. Changes in teachers' mathematical knowledge, beliefs, dispositions, and in the collaborative structures that support learning often occur in small increments, with advances in any one of them depending on advances in the others (Kazemi and Franke, 2004). Teachers' growth is often incremental, nonlinear, and iterative, proceeding through repeated cycles of inquiry outside the classroom and experimentation inside the classroom (Clarke and Hollingsworth, 2002; Lubinski and Yazujian, 2002). For example, Jaberg, Lubinski and Yazujian (2002) reported on a teacher who responded to professional development by changing her practice to elicit and respond to students' thinking more often. After making this change, she found she needed to better understand her students' thinking, which in turn convinced her that she needed to increase her own mathematical content knowledge. Similarly, studies of teachers' collaborative work suggest that increases in practice-focused collaboration and content knowledge can build incrementally on each other, as teachers' explanations of their practice lead to questions about the mathematics content (Peng, 2007).

Systemic Support

Systemic support influences the impact of professional development programs. A number of studies have reported that the nature and degree of principal support for a particular professional development program influences its impact (Desimone, Smith and Phillips, 2007; Woodbury and Gess-Newsome, 2002). For example, Jaberg, Lubinski and Aeschleman (2004) describe a number of different ways that one principal supported and encouraged the work her teachers were undertaking through their professional development, including building support among parents and other community members, making time during faculty and grade level meetings for teachers to discuss mathematics instruction, and being flexible about assessments of students' learning.

Other system factors can also make a difference. Garet et al.,(2001) found that professional development was more effective when teachers perceived it to be consistent with their own goals and with state and district standards; other studies have reported that the nature and consistency between professional development and system messages about mathematics teaching and learning affect teachers' learning (Tschannen-Moran and Hoy, 2007). Presumably, then, those responsible for professional development should attend to building coherent support for participating teachers. This support should come from a variety of sources, including principals, district and state officials, and parents.

Opportunities for active learning

For more than a decade, the literature on promising practices in mathematical professional development has advocated active involvement of teachers inquiry and problem solving with respect to both mathematics and instruction (e.g., Putnam and Borko, 1997). Large-scale research studies support these recommendations, that professional development that offered opportunities for active learning- for example, planning lessons; observing other teachers and being observed; reviewing students' work; and making presentations, writing papers, or leading discussions- were associated with teachers' reports of increased knowledge and skills.

CONCLUSION

The vast majority of studies about teachers' professional learning follow teachers' post-professional development for a year or less, so evidence regarding the long term impact of mathematics professional development on teachers' knowledge or instructional practices is limited. In fact, even in the short term, the impact of professional development may be less than as suggested by the large-scale studies, which rely on self-report.

Despite the limitations of the current review, substantial support exists for focusing mathematics professional development on the four broad goals area. It can be established from the literatures, that effective professional development processes the following characteristics among others;

Focused on specific goals that are clearly connected to mathematics and mathematics teaching;
Supports the development of teachers' knowledge of mathematics;
Supports the development of teachers' knowledge of how children learn mathematics;
It's active learning- it gives teachers the opportunity to try new ideas and discuss them;
Includes support from knowledgeable others;
Values teachers as professionals.

Although research on professional development is still

emerging, the goals, effectiveness, and features that this review has identified emerge from a substantial number of studies and offer the best current guideline for mathematics educators in Nigeria in planning professional development programs.

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