Article

The Understanding of Effective Professional Development of Mathematics Teachers According to South Sudan School Context

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Abstract: This paper aims to provide an understanding of effective professional development (PD) for mathematics teachers according to the context of South Sudan schools. Hunsicker's (2011) checklist of effective PD was taken as a framework. The framework has five characteristics—supportive, job-embedded, instructional focused, collaborative, and ongoing—and these five characteristics have been used for shaping the study. Interviews were designed and administered to educational officials, principals of two schools, and six sampled mathematics teachers, patterning their understanding about effective PD of mathematics teachers in the South Sudan school context. The analysis showed that the types of PD that exist in the South Sudan school context include the preparation of a lesson plan and the scheme of work for novice teachers, a weekly professional participation of teachers within their working hours, and informal dialog and guidance among peers. In addition, some unqualified teachers are sent to teacher training institutions during holiday times, which can be regarded as a kind of in-service and continuous PD. Our findings are that most of the participants do not have a clear view of what effective PD means. The participants mentioned aspects that can be seen as parts of effective PD according to the literature, but none of them had a holistic or explicit understanding. There is a need to engage those stakeholders to work deeply on aspects of effective PD if a meaningful improvement in student learning is to happen in classrooms.

Keywords: understanding of effective PD; professional development; educational officials; principals; mathematics teachers

1. Introduction

South Sudan is one of the world's youngest nations and attained its independence from Sudan on 9 July 2011. Despite the attainment of independence, its educational system is known to be of poor quality [1]. This poor quality in the educational system has been attributed to a lack of qualified teachers, irregularly paid salaries of teachers, poor infrastructure, low investment in education, and harmful cultural norms [2–4]. These factors have hampered the educational progress in the country.

According to [1,2], delineated features such as engagement of untrained teachers and shortage of teacher training institutes (TTI) have also played substantial roles in paralyzing the educational development in the country. This manifests itself through the involvement of both untrained and unqualified teachers in the teaching profession, where they are unable to deliver adequate teaching and develop their career satisfactorily due to the inadequate skills and knowledge possessed. Ref. [3] power highlights the following relevant points: The education system in South Sudan is ranked among the lowest in the world for primary and secondary enrollment. South Sudan is faced with the almost impossible task of tripling its teacher work force, but the quantity and quality of training required cannot be delivered through existing teacher training institutes (p. 368).

In order to address this crucial matter of the poor quality of the educational system in South Sudan, providing robust teacher training (TT) or professional development (PD) is vital. Teachers are key resources for students to learn mathematics. Teacher knowledge and skills have a huge impact on students' learning [5,6]. In order to improve student learning, the quality of teacher training and further teacher professional development is a key factor. Equally, teachers' understanding, perception, and belief about effective PD plays a considerable role in changing the engagement with PD.

In the South Sudan context, several scholars and academics have different views about teacher training or PD that are being conducted. Besides, the PD's have been facilitated by different shareholders, NGO's and others including the state, and the national educational officials. The kind of PD provided by these different bodies has not been studied very well. Therefore, the focus of this study is to gain understanding of what effective PD means, in connection to the teaching and learning of mathematics, among the educational officials, principals, and mathematics teachers. Hence, the following research questions guided this study.

What types of professional development exist in South Sudan?

What are the elements that entail effective PD according to educational officials, principals, and the mathematics teachers?

What is effective PD for mathematics teachers in South Sudan?

The answers to these research questions are important in order to develop further the teaching training and teacher development, e.g., in order to introduce more student-centered approaches to mathematics teaching.

2. Theoretical Framework

2.1. Literature Review on Professional Development (PD)

PD has a broad definition among several stakeholders, including teachers. PD literally refers to continuing education and career training after a person has entered the workforce in order to help them develop new skills, stay up to date on current trends, and advance their career. Ref. [7] defines PD as "structured professional learning that results in changes in teacher practices and improvements in student learning outcomes" (p. 87). According to OCED [8], PD is defined as "activities that develop an individual's skills, knowledge, expertise and other characteristics as a teacher". This definition refers to any formal and informal training, which could be seminars, workshops, courses, or collaborations among teachers and schools but excludes pre-service teacher training. Ref. [9] defines the term 'professional development' as "the process by which, alone and with others, teachers review, renew, and extend their commitment as change agents to the moral purposes of teaching; and by which they acquire and develop critically the knowledge, skills, planning and practice with children, young people and colleagues through each phase of their teaching lives" (p. 4).

PD plays a substantial role in enhancing teachers to become competitive in teaching as well as improving students' performance. In general, [10] stated that "teacher PD is a continuous and personal learning and growth, in which teachers participate voluntarily" and recognizing this nature of PD is vital when stakeholders engage in any PD program (p. 1).

Elements such as focused study groups, teacher collaboratives, and long-term partnerships are some of the components of PD that aim at providing teachers with the means of setting new ideas in relation to their individual and institutional histories, practices, and circumstances [11]. It is imperatively stated that coaching provides teachers with technical feedback, guides them in adapting new practices to the needs of their students, as well as helping them to analyze the effects on the students' performances.

Additionally, [9] stresses different types of PD that involve courses and workshops, education conferences and seminars, qualification programs, observation visits to other schools, participation in the network of teachers, individual and collaborative research, and mentoring and peer observation.

Ref. [12] highlighted three major types of PD: conference presentations, workshops, and intensive training. Conference presentation deals with the descriptions of classroom practices, their intended outcomes, the manner in which the different practices were related, and examples of practices in the preschool classroom model. Workshops can be conducted between 1, 2, and 3 days with a duration of between 4 and 6 h per day; otherwise, for 2 to 3 days it may take 10 to 14 h as the duration time. The intensive training includes both weeklong training institutes and on-site training that is conducted in the participants' school classrooms.

The categories for these types of PD are identified to range from short-term training to longer-term courses. Short courses are profoundly recognized as appropriate for providing new skills and knowledge as longer courses are not always practically, economically, or politically feasible [12–15].

PD boosts the teachers' skills in implementing activities in their teaching–learning process by focusing on teachers' knowledge, the practice of instruction, and the learning outcomes of students [16,17]. Indeed, the main prerogative of PD is to ensure that teachers acquire the latest skills and knowledge that will expedite better student achievement and, hence, foster attainment of quality education. There are many different forms or modes of PD (see Table 1). The following table summarizes some of the different forms, as mentioned in [8,18]. This research recognizes such modes or types as PD that contribute to teachers' change or development.

Table 1. Different modes and types of PD.

Modes of PD according to [18]	Types of PD according to [8] (p. 50)
- individual reading/study/research - observation - coaching - mentoring of new educators by more experienced colleagues - team meetings	- courses/workshops - education conferences or seminars - qualification program (e.g., a degree program) - observation visits to other schools - participation in a network of teachers formed specifically for the PD of teachers; - individual or collaborative research on a topic of professional interest; - mentoring and/or peer observation and coaching, as part of a formal school arrangement; - reading professional literature; - engaging in informal dialogue with peers on how to improve teaching.

2.2. Effective Professional Development (EPD)

What is meant by effective PD? A large body of research identifies principles and elements that constitute effective PD programs [10,19–22]. The term effective is somehow controversial, as one effective PD may not be as effective in another context or another education system. Ref. [23] highlights the difference between high-income and low- and middle-income contexts; they propose eight principles for designing effective teacher PD and learning in sub-Saharan Africa (SSA). These principles are relevant for the current study context as it is part of the SSA. The principles (sub-principles) include the following: it should focus on student learning and on effective teaching practices. It should promote teacher learning and recognize teachers as professionals. There should be sequenced, long-term, and regular programs. School-based PD and school-based peer facilitation should be provided rather than relying on 'external experts', favoring whole-school approaches; school leadership is a crucial component of ensuring effective teachers' PD. Teacher status and motivation, open educational resources or teaching and learning materials, use of digital technology, and coherent policy environment in which to advance educational institutions [23].

Various other studies have been conducted to identify suitable effective PD programs for mathematics teachers in improving teacher competence in teaching and learning. Ref. [24] stresses that effective PD programs must be designed to enhance the level of teaching skills in the classroom. Ref. [25] accentuated the three core features of effective PD that demonstrate both the significant and the positive effects on teachers' knowledge and skills, and their classroom practice. These features include *(a) a focus on content knowledge, (b) opportunities for active learning, and (c) coherence with other learning*. Additionally, other authors argued that there is a research consensus on the main features of effective PD that are critical to increasing teacher knowledge and skills, thus improving their practices [25–30]. Effective PD programs must be designed to enhance the level of teaching skills in the classroom [16,19,21]. Darling-Hammond Gardner [21] identified seven widely shared features of effective PD based on an extensive review of the literature [21]. They concluded that effective PD is content focused, meaning the PD activities should focus on subject matter content and how students learn that content. It incorporates active learning, providing teachers' opportunities to get involved, such as by observing and receiving feedback, analyzing student work, or making presentations, as opposed to passively sitting through lectures. It supports collaboration and promotes collective participation among teachers from the same grade, subject, or school in PD activities together to build an interactive learning community. It is coherent in such a way that what teachers learn in any PD activity should be consistent with other PD; with their knowledge and beliefs; and with school, district, and state reforms and policies. Lastly, it is done for a reasonable duration of time [21]. Hence, the notion of effective PD is an ongoing research theme, and it is problematic to give a comprehensive framework that can work for all places and all times.

2.3. Hunzicker's (2011) Checklist as Conceptual Framework

Summarizing the existing principles and frameworks that guide designing and implementing an effective PD, this research is guided by the conceptual framework provided by [19]. The framework has five characteristics for an effective PD: *supportive, job-embedded, instructional focused, collaborative, and ongoing*. The rationale for choosing [19] is its comprehensiveness as well as simplicity, at least for the researcher. It has room for interpretation by the researcher to involve several aspects of effective characteristics of PD that are raised by other researchers, as mentioned above. In addition, [19] provided a checklist for school leaders, and even for those who want to design and implement effective PD. These characterizations of effective PD are presented briefly as follows.

Supportive: This is when PD considers the needs, concerns, and interests of individual teachers along with those of the school or district goals. This involves teachers' personal and professional needs, individual learning preferences, and input regarding what and how they will learn. It is eminently noted that PD is customized by school, classroom, and grade level, engaging individuals from all levels (i.e., teachers, administrators, and paraprofessionals).

Job-embedded: A PD becomes effective when it connects to teachers' daily responsibilities. It becomes authentic when it is seamlessly integrated into each school day, engaging teachers in activities such as coaching, mentoring, and study groups. Teachers are inclined to take job-embedded PD seriously because it is 'real'.

Instructional focused: This occurs when the PD includes the study and application of content and pedagogy with emphasis on student learning outcomes. There is feedback to teachers as well as authentic accountability from teachers to their students' learning; Ref. [25] also noted this characteristic. In addition, effective teaching considers the variations among teachers due to different factors such as teaching assignment, career stage, and individual feelings about innovation.

Collaborative: Effective PD deals with engaging teachers in both active and interactive learning. It becomes active when teachers engage physically, cognitively, and emotionally through activities such as problem solving, discussion, simulations, role-play, and applications also emphasized by [21] in this aspect.

Ongoing: PD is conducted in such a way that it is a combination of contact hours, duration, and coherence. Consequently, the more time teachers engage in PD, the more likely their teaching practice is to improve. Nevertheless, PD is most effective when teachers have multiple opportunities to interact with information and ideas over several months, which is also noted by [21].

3. Methodology

This study is part of a doctoral study on a PD that focuses on student-centered teaching–learning for mathematics teachers in South Sudan. A design-based research (DBR) methodology is employed in the study and the current study is part of that design in such a way that the researcher prepares the intervention by understanding the participants' meaning about effective PD [19,21,31]. Hence, the first cycle in the study is to understand the context, initial conditions, participants, and their histories in relation to implementing effective PD [32]. For that, a qualitative research approach was employed to shed light on the meaning of effective PD of mathematics teachers in the South Sudan school context. The rationale for using the qualitative design research approach is that it serves in describing, explaining, reporting, and creating of key concepts; theory generation [33]; and testing as well as integrating design and research [34]. It is noted that the qualitative research connotes the use of words rather than numbers according to [35] (p. 366). This is due to the nature of information obtained, which is predominantly in the form of words and explanations instead of being of a numeric nature. Sandelowski [36] holds the view that qualitative research focuses on the attitudes towards understanding, experiences, and interpretations by humans of the social world and how to enquire about all of these [36] (p. 893). This peremptorily underpins the merits for adopting the qualitative strategy in this methodological stance.

Two primary schools were conveniently sampled. Each school was to offer three mathematics teachers who were teaching grade five classrooms. A total of six primary mathematics teachers participated in the study. There was also participation of two educational officials and the principals of the two schools. The criteria for this convenience sampling were based on the opportunity of the participants to serve in the data collection process [37].

In addition to that, convenient sampling involves choosing the nearest individuals to serve as respondents and continuing that process until the required sample size has been obtained of those who happen to be available and accessible at the time [33]. Three types of interviews were designed (see Table 2). The first interview was administered to the educational officials. The second interview was administered to the principals of the two schools. The last interview was administered to the six primary mathematics teachers. The purpose of conducting these interviews was to understand the interviewees' definitions about effective professional development. Table 2 summarizes the three groupings where data were gathered from.

Table 2. The three groups of interviews and abbreviations used for the interviewees.

Educational officials	EO1 and EO2
Two School Principals	P1 and P2
Six Mathematics teachers	T1, T2, T3, T4, T5, and T6

3.1. Data Analysis

The researcher applied deductive analysis. Deductive analysis, also called a priori analysis, applies theory and predetermined codes to the qualitative data [38]. The deductive analysis approach helps the researcher to organize data into categories so that the finding is aligned with the research questions, and it also helps the researcher to apply a conceptual framework developed a priori [38]. The codes are organized by the framework for an effective PD developed by [38]. The concern of the study was specifically based on how

the data gathered by the interviews could constitute the synthesis for analysis of the information. The interviews were critically read, organized, categorized according to their themes, described, and explained according to the definition of the participants' situation [39]. The coded (see Table 3) and filed notes were later used by the researcher to explicitly give the description, understanding, and explanation for the definition of the effective PD, subsequently leading to the interpretation of the findings.

Table 3. Coded categories of characteristics of effective PD adapted from Hunzicker (2011).

Effective Professional Development
Supportive characteristics (S)   S1—Does it combine the needs of individuals with school/district goals?   S2—Does it engage teachers, paraprofessionals, and administrators?   S3—Does it address the learning needs of specific schools, classrooms, grade levels, and/or teachers?   S4—Does it accommodate varying teaching assignments, career stages, and teacher responses to educational innovation?   S5—Does it accommodate individual learning styles and preferences?   S6—Does it integrate teacher input and allow teachers to make choices?
Job-embedded characteristics (JE)   JE1—Does it connect to teachers' daily responsibilities?   JE2—Does it include follow-up activities that require teachers to apply their learning?   JE3—Does it require teachers to reflect in writing?
Instructional-focus characteristics (IF)   IF1—Does it emphasize improving student learning outcomes?   IF2—Does it address subject area content *and* how to teach it?   IF3—Does it help teachers to anticipate student misconceptions?   IF4—Does it equip teachers with a wide range of instructional strategies?
Collaborative characteristics (COL)   COL1—Does it engage teachers physically, cognitively, and emotionally?   COL2—Does it engage teachers socially in working together toward common goals?   COL3—Does it require teachers to give and receive peer feedback?
Ongoing characteristics (OG)   OG1—Does it require a high number of contact hours over several months' time?   OG2—Does it provide teachers with many opportunities over time to interact with ideas and procedures or practice new skills?   OG3—Does it 'build' on or relate to other professional development experiences in which teachers are required to engage?

3.2. Validity and Reliability

Reliability and validity are intertwined but they mean different things. Reliability refers to how consistently a method measures something. There are two types of reliability—namely, internal and external—which the researcher adopted to apply in this study. Internal reliability was articulated when the researcher used devices such as a recorder and camera to independently collect the data and analyze it thematically [31,34,40]. Consequently, the data collected by interviews were documented and transcribed to indicate the extent of subjective judgement, which was in accordance with the inter-rater reliability. Of course, external reliability emerged when the researcher ensured that the conclusion of the study depended both on the subject and the condition under which the investigation was conducted [31,34,40]. This was evidential on account of considering the replicability of the interpreted findings as presumed from the recorded data during the interviews and, subsequently, leading to the drawing of the conclusion [31,34].

Considering the internal validity, the researcher established questions that led to the reasoning and the soundness of the respondents and, hence, navigating the conclusions. External validity was viewed when the researcher posed questions of whether the results of a study can be generalized beyond the specific research context. It was in this context that

the issue of how participants were conveniently selected to participate in research became crucial [40].

3.3. Ethical Consideration

The study emphasized ethical consideration by obtaining informed consent, anonymity, and confidentiality [41]. In this context, we obtained informed consent from the participants by informing them about the process of the research and their views regarding participation in it. This was conducted to obtain their options when participating in the study.

"Anonymity and confidentiality shall be assured to them that their participation in the study as participants shall not be identified as well as guaranteeing them the security of their responses" [41], and to indicate assurance of the reliability of the data that one will be collecting. Furthermore, the study respected every individual opinion and suggestion regarding what s/he answered in the interviews or during the classroom observation.

4. Findings

The findings for the research are discussed according to the research objectives presented above. The data collected from the educational officials, principals of the schools, and the six sampled mathematics teachers through the interviews that were administered to them are categorized into three themes. The first is about the type of PD that exist in the South Sudan educational system; the second deals with the elements of effective PD; and the last one concerns the understandings of effective PD by the officials, principals, and mathematics teachers.

4.1. Types of Professional Development That Exist in South Sudan

The first research question provides understanding when it comes to the type of PD that exist in South Sudan. It is always for building up the ground for the main focus of this work—that is, the understanding of effective PD among some of the stakeholders (Educational officials (EO), Principals (P), and Teachers (T)). EO1 stated that the type of PD that the State Ministry of Education offers to the teachers is in-service training. He continued by stating that this in-service training is specifically administered to primary teachers at the state level. EO2 claimed that there are three considerable types of PD that the National Ministry of General Education offers to the teachers: pre-service, in-service, and continuous professional development. In-service training is conducted for the government primary teachers who have been in the payroll and either have the certificate or not. It always takes a period of three years for them to complete the prescribed module-based courses. In addition, continuous PD is made for all the teachers to update themselves on the current trends in education. EO2 further stated that "Both the in-service and CPDs are provided by the directorate for Teacher Development and Management Service (TDMS) of MoE of South Sudan in collaboration with Curriculum Foundation (CF) in UK training at the country education centers and the well-recognized higher institution, in this case the University of Juba, takes the mandate for the assessment. Primarily the trainings focus on pedagogical knowledge and there is a process of preparing new material for subject methodology. These two programs provide a kind of qualification program for diploma".

Such teacher trainings are basically qualification programs provided as training/ workshop courses. Both P1 and P2 acknowledged that the types of PD that existed in their respective schools included help with how to make a lesson plan and how to prepare the scheme of work. P1 stressed that assistance with the preparation of a lesson plan and scheme of work were to equip new teachers that have no formal training on the teaching profession with some fundamental knowledge on how a teacher works. Further, P1 reflected on the following: "Professional development is a way an education system progresses further. Many teachers improve their skill, training, and knowledge of teaching. In schools we train those who are not qualified. We also send them for training outside of school to the teachers training colleges/institutes during the holidays. Formally, once in every week we have gathering to discuss about relevant issues pertaining to the teaching

and learning process. Of course, those of us who have qualified trainings with experience are engaged in helping daily those who needed it informally".

P2 supplemented that preparation of a lesson plan and scheme of work were to train teachers to see both the overview and the detail activities in a subject they are teaching. Further, the six teachers were asked to share the types of PD they receive in their career. Table 4 summurizes their reflections.

Table 4. Types of PD in South Sudan according to six teachers at two schools.

T1, T3, T4, T6	training on lesson plan and preparation of scheme of work
T2	how to use new strategies and approaches for teaching mathematics
T5	how to conduct classroom discussions for the pupils

T1, T3, T4, and T6 said that lesson plan and scheme of work are the types of PD that have been explicitly administered through conferences, workshops, seminars, mentoring, and coaching as the existing types of PD. T2 and T5 viewed types of PD according to the new strategies, approaches, methods, and classroom discussion, which were indirectly connected to the following types of PD: Participating in a network of teachers formed specifically for PD of teachers and engaging informal dialogue with peers on how to improve teaching. Hence, you can observe that there is some discrepancy in finding out the types of PD among the teachers.

Subsequently, commonalities do persist; preparation of lesson plan and scheme of work are stated, both explicitly (T1, T3, T4, and T6) and implicitly (T2, new strategies and approaches for teaching; T5, methods and conducting classroom discussion). It is noted that all these features stated by the teachers can be observed in line with [8].

4.2. Elements of Effective PD by Educational Officials, Principals, and Mathematics Teachers

In line with the second research question, the three groups of stakeholders' PD for mathematics teachers were asked about their meaning regarding effective PD. Their responses are organized according to the characteristics of effective PD given by [19]. Using the five main categories and nineteen sub-categories that characterize the effective PD (see Table 3) as conceptual framework and the researchers' interpretation of the data through coding, the elements that entailed effective PD are described below.

EO2's reflection about the meaning of effective PD is summarized as follows:

" . . . the in-service and CPD programs are done during the holidays. There are three semesters and after each semester, those teachers enrolled in these programs will follow the training at the county education centers. . . . Those teachers who showed weakness, an extra school based called face-to-face follow up is done by the mentors in the program. Basically, mentors follow up teachers in schools to get feedback if teachers have benefited from the programs, they are enrolled in".

Analyzing EO2's reflection, several of the subcategories of [19] seem to be included. However, EO2 was not certain about the characteristics of effective PD. EO1 expressed that the elements that constituted effective PD involved all the necessary things for teaching such as lesson plan, scheme of work, and the practical bases (S3, IF2) to enhance teachers' understanding. EO2 outlined elements such as code of conduct, planning, lesson plan, scheme of work, methodology, and administrative, whose codes are correlated to S2, S3, and IF2 (see Table 3). P1 stated that the element of effective PD includes effective teaching, listening, questioning and answers regarding the methods of teaching (IF4).

"Effective PD has something to do in improving how teachers use teaching aid (IF1, IF2); all other facilities to make teaching available for improving learning (IF4); engaging teachers to be well equipped for teaching (OG3)".

P1 described the types of PD that are available and mentioned that teachers gather once a week (OG1 and JE1) and participate in discussion, and the seniors provide informal dialogue and peer support (COL3) [8,19]. P2 stated the elements of effective PD such as the

methodologies and skills of teaching (IF4), working together and sharing ideas (COL2), and attending training (OG3). Though P2 outlined these elements as effective PD, they were observed to represent the sub-categories of effective PD. In brief, P2 defines the following: "Effective PD is a training done to teachers to equip them with the skills and knowledge on the modern way of teaching. It includes features such as methodologies and skills of teaching (IF4), working together and sharing ideas (COL2) and attending training (OG3)". The six teachers' views about what constitutes effective PD is summarized in Table 5.

Table 5. The six teachers' reflections on effective PD.

Teachers	Elements of Effective PD Summarized by the Six Teachers
T1	Conducive environment, tools, and skills
T2	Active participation, discussion, consultation, knowing the level of the students' understanding, and the unity of learners.
T3	Group work, discussion, demonstration of equipment to the learners, and explanation of activities
T4	Collaboration, classroom management, tools, and manipulatives
T5	The teaching learning aid, lesson plan, and scheme of work
T6	Active participation and giving the right information to the learners

T1 suggested the elements for effective PD such as a conducive environment, tools, and skills (OG2). T2 outlined elements such as active participation, discussion, consultation, knowing the level of the students' understanding, and the unity of learners (IF4, COL2) as constituting effective PD. T3 stated that the elements for effective PD involve group work, discussion, demonstration of equipment to the learners, and explanation of activities (COL2); meanwhile, T4 outlined that elements for effective PD such as collaboration, classroom management, tools, and manipulatives (COL2, IF4) constitute effective PD. Meanwhile T5 stated that the elements for effective PD included the teaching–learning aid, lesson plan, and scheme of work (IF1). According to T6, the elements for effective PD involve active participation and giving the right information to the learners (IF4).

We see that there is some disparity in the understanding of what constitutes effective PD among the teachers, and their understanding does not confirm to the literature. Commonalities do, however, exist, as active participation is mentioned, both explicitly (T2, T4, T6) and implicitly (T1: conducive environment, T2: discussion, T3: group work). All these aspects mentioned by the teachers can be seen in light of the five criteria by [19]. The teachers did not mention explicitly that PD should be ongoing, but the four other criteria can be seen to be present.

5. Discussion

5.1. Types of PD in South Sudan Context

South Sudan, as a young nation, and like the other SSA countries, faces considerable challenges to recruit a good number of qualified applicants to train as teachers, particularly mathematics teachers. "Those who are attracted to teaching as a career all too often receive inadequate training and, as a consequence, enter service ill-equipped to meet the considerable demands of the profession" [42]. Therefore, PD of teachers is key for the education system. As [9] asserted, PD is a process by which teachers engage themselves to develop knowledge, skills, and competencies so that they become agents of change. In South Sudan, as both educational officials confirmed, there are two major programs (types) of PD for those teachers who are enrolled under the government payroll system: in-service and CPD. In some cases, it is also possible to include the pre-service program, which is primarily designed for those who finish high school and join National Teacher Training Institiues (NTTI), as a third PD program for teachers in South Sudan. It is notable that

there are some teachers who have joined the teaching profession without qualification, which is a common trend across SSA countries, making in-service PD a necessity [1,42].

There are three types of PD in the South Sudan school system. These PDs are generally of the formal programs led by the MoE in the country. These include courses/workshops, education conferences or seminars, qualification programs (e.g., a degree program), participation in a network of teachers formed specifically for the PD of teachers, and engaging in informal dialogue with peers on how to improve teaching. Though these teachers did not state explictly the types of PD, based on the features mentioned, they are presumed to be available.

In addition, there exists engagement of experienced and novice or weak teachers in informal dialogue to improve teaching [8]. Though these teachers did not state explictly the types of PD, but based on the features mentioned, they are presumed to be available. Other than these programs, there are no other small-scale/large-scale meaningful PD types. Thus, important aspects that are missing are participation in networks of teachers formed specifically for the PD of teachers; individual or collaborative research on a topic of professional interest; mentoring and/or peer observation and coaching, as part of a formal school arrangement; observation visits to other schools; reading professional literature; and education conferences or seminars, all of which are emphasized by [8]. Some of these PD types might be embedded in the three others major PD programs in South Sudan. Further, these programs so far do not include the subject methodology, which is peculiar in equipping teachers with a mathematical knowledge and pedagogical skills to help their students master the subject. EO2 reflected that "the Directorate TDMS of the MoE South Sudan in collaboration with CF in UK are preparing subject focused methodology in relation to the existing curriculum", something which may help to amend the situation.

5.2. Meaning of Effective Professional Development in South Sudan Context

The meaning of effective PD according to educational officials, principals, and teachers in South Sudan showed very limited aspects of the characteristics defined by [11]. The result is consistent with other findings across the Sub-Saharan African countries [42]. EO1 defines effective PD as a training that gives skills and knowledge to the person to do the right thing. EO2 refers effective PD to teachers who are either qualified or not, but they are trained with the skills that lead them to the award of a certificate of attendance. Such reflections are directly related to the general PD definition in literature [7,10,11]. Among the 19 subcategories of characteristics of effective PD, only S2, S3, and IF2 were mentioned by the reflection of the educational officials in the context of the three types of PD. The information revealed that neither of the two Director Generals (DGs) mentioned categories under job-embedded (JE), collaborative (COL), and ongoing (OG), and even the other two categories that were mentioned were not exhaustive in terms of the checklist provided by [11].

Both P1 and P2 have referred to effective PD as training that equips teachers to teach effectively, which incorporates teaching aids and learning materials in the context of the three PDs mentioned above and the other types of PDs they claim are happening at their respective school. They both refer to the kind of training that teachers experience in the three different PD provided by the MoE in the country. In fact, the reflections about what entails effective PD includes several characteristics of the checklist provided by [11]: IF1–4, JE1, and OG1. For these principals, participation in a school-based meeting where their teaching activities are discussed among the teachers, mentoring and/or peer coaching, and trainings in preparation for lesson planning and preparation of scheme of work is counted as PD; hence, the categories of effective PD such as Job-embedded and Ongoing are included.

Among the six teachers at the two schools, the meaning of effective PD has a very broad meaning and refers to the characteristics of effective PD including IF1, IF4, COL 2, and OG2. Their reflection includes the activities at the school such as those of the principals' meaning. In addition, teachers have included the Collaborative characteristics; specifically,

the characteristic COL2 "it engages teachers socially in working together toward common goals" is mentioned several times. For them, effective PD contributes to the progress of teachers in learning accurate information about mathematics.

Slater and colleagues Ref. explains effective PD as structured and facilitated activity for teachers intended to increase their teaching ability [20]. This eminently works by capacitating teachers with prerequisite packets of techniques and tactics to boost their teaching profession. In addition, Darling-Hammond Gardner Ref. refers to effective PD as the structured professional learning that results in changes to teacher knowledge and practices, and improvements in student learning outcomes [21]. It is essential that effective PD articulates the parameters of enhancing current strategies and approaches to facilitate improved outcomes of the students. In general, the finding reveals that none of these participants gave an accurate and comprehensive definition for effective PD as provided by the different literatures mentioned above, specifically in the context of the conceptual framework provided by [11].

6. Conclusions and Implication

The study articulates to understand the meaning of effective PD of mathematics teachers in the context of South Sudan schools. In order to establish that, the types of PD that are available in the country's context are discussed. The findings show that the types of PD that exist in the South Sudan school context are the three formal ones provided by the country's MoE: pre-service, in-service, and continuous PD. Structured, invested, and school-based do not formally exist. Most importantly, the five elements of effective PD described in [11] are novice concepts to the education system. Only the formal programs desgined by the government and other stakeholders exist to improve teachers learning. There could be many reasons for this, such as lack of professionals who can coach and facilitate school-based PD programs, lack of investment, and so on. This could be the pattern among the SSA countries [1,8,42].

Understanding the different types of PD and meanings about effective PD could help teachers, principals, and education officials to boost professional learning, which can improve student learning and achievement. By implication, it is essential that teachers are trained and strengthened with the three types of PD so that they are equipped with the prerequisite knowledge and skills to boost their effective teaching and learning. Additionally, it is also substantive that these participants are capacitated (equipped) with the five elements of effective PD. This can be facilitated by training these teachers with activities that are supportive, job-embedded, have instructional focus, collaborative, and have ongoing elements. Challenges include insufficient finances to fund operationalization by the Ministry of General Education and lack of enthusiasm by both educational designers and implementors to see that recommended types of effective PD programs are implemented.

This is a preliminary background study for investigating the impact of an intervention-based PD on student-centered mathematics instruction in South Sudan [43]. The broader aim is to see the shift in teachers' practice in connection to student-centered pedagogy in the teaching and learning of mathematics in the South Sudan context [44]. Studying the understanding of teachers, principals, and educational officials about effective PD helps further to design and implement the intervention via Design-Based Research (DBR). The study encountered limitations of time and access to information from the respondents. It was difficult for the researcher to gather information from the respondents since they were busy with teaching schedules. The researcher was flexible in adjusting to their time and motivated them to participate differently.

Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki, and approved by the Ethics Committee of NSD–Norwegian Centre and South Sudan MoE.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: Not applicable.

Conflicts of Interest: The authors declare no conflict of interest.

Abbreviations

CF	Curriculum Foundation
COL	Collaborative
CPD	Continuous Professional Development
DBR	Design-Based Research
EPD	Effective Professional Development
EO	Educational Official
IJ	Instructional Focus
JE	Job-Embedded
MoE	Ministry of Education
OG	Ongoing
P	Principal
PD	Professional Development
S	Supportive
SSA	Sub-Saharan Africa
T	Teacher
TDMS	Teacher Development Management service
TTI	Teacher Training Institute

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