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# Differentiating instruction for learners' mathematics self-efficacy in inclusive classrooms: Can learners with dyscalculia also benefit?

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Poor mathematics self-efficacy (MSE) has been recorded among learners at all levels in Nigeria. The study reported on here sought to establish the efficacy of differentiated instruction (DI) in raising learners' MSE in inclusive settings. We also explored the differential effects of DI on the MSE of learners with dyscalculia, as well as on high- and low-achieving learners. We adopted a control group quasi-experimental research design involving 1 experimental and 1 control group. A total of 4 mathematics teachers and 158 Senior Secondary II (SSII) learners in 4 regular classes participated in the study. Mathematics teachers participated in a one week DI training workshop to equip them with DI skills for whole-term mathematics instruction. The Students' Mathematics Self-efficacy Scale (SMSES) was used for data collection at pre- and post-intervention evaluations. Quantitative data were analysed using descriptive statistics and analysis of covariance (ANCOVA). The major findings reveal that using DI led to significant improvements in learners' MSE. Prior achievement (PA) had a significant influence on MSE; however, DI was effective in reducing the negative effects of poor PA on the self-efficacy of low-achieving learners and learners with dyscalculia. It was concluded that DI offers teachers the impetus to help all learners to improve their self-efficacy in mathematics.

**Keywords:** differentiated instruction; dyscalculia; flexible grouping; inclusion; mastery; mathematics; ongoing assessment; prior achievement; problem solving; self-efficacy

## Introduction

Since the Salamanca Education for all Statement (United Nations Educational, Scientific and Cultural Organization [UNESCO], 1994), inclusive education has stood to be widely adopted in education policies and practice across the world. Inclusive education, therefore, qualifies as a global education policy (Verger, Novelli & Altinyelken, 2012). Learners with all kinds of learning limitations and strengths are currently enrolled in mainstream education settings. The inclusion of learners with diverse learning abilities has increasingly posed difficulties in teaching-learning processes worldwide. For instance, teaching in inclusive education has some implications including creating and maintaining a supportive classroom, accepting diversity, and respect for diversity. Equally, making fundamental changes in curriculum implementation to accommodate heterogeneity of classrooms through cooperative learning approaches is always sought, while preparing and encouraging teachers to use interactive teaching techniques based on learners' needs, involving parents and learners in the planning process (Rachmawati, Nu'man, Widiasmara & Wibisono, 2016). Rather than placement of some learners who have additional needs in a regular classroom, inclusion entails addressing obstacles to participation of all learners (Engelbrecht, Oswald & Forlin, 2006). Although some developed countries are increasingly at ease with the implementation of inclusive education, African countries still lag behind in terms of implementation (Adetoro, 2014; Charema, 2010; Srivastava, De Boer & Pijl, 2015).

African countries present elevated challenges for both the school systems and the teachers with respect to meeting the needs of all learners irrespective of their personal limitations in learning (Mupa & Chinooneka, 2015). This is because of some culturally-based assumptions about capabilities of persons with disabilities and a lack of competence on the part of the teachers (Charema, 2010; Srivastava et al., 2015). Teaching and learning are persistently following the old teacher-centred pedagogies (Schweisfurth, 2011; Spratt & Florian, 2013; Srivastava et al., 2015) which rarely meet the needs of learners with special needs. In Nigeria, it has been identified through research that teachers in mainstream schools are poorly equipped to implement inclusive education pedagogies and lack the skills necessary to optimise learning across learners' abilities/disabilities (Agunloye, Pollingue, Davou & Osagie, 2011). They are also incompetent in evaluative services for learners with disabilities (Agunloye et al., 2011). This is especially problematic, given the diversity in learners' abilities, readiness levels and learning profiles in regular classrooms, and following inclusion (Florian & Black-Hawkins, 2011; Landrum & McDuffie, 2010; Rachmawati et al., 2016; Thakur, 2014). Teachers are faced with the challenge of helping all learners benefit or cope effectively with learning experiences apposite for their grade level through developing skills for self-regulation (Florian & Black-Hawkins, 2011; Gillespie Rouse & Kiuhara, 2017; Lingo, Barton-Arwood & Jolivette, 2011; Nel, Nel & Hugo, 2013). Yet, the majority of teachers tend to teach to the middle (a one-size-fits-all approach) and then fail to capture learners' different learning needs. Teachers may also display poor disposition to facilitating access and participation for all their learners (Walton, 2011). As a result, a good number of learners are either being over-challenged or under-challenged (Berman, Schultz & Weber, 2012; Hornby, 2011; Schmitt & Goebel, 2015). It has been recorded that 67% of learners' poor performance in mathematics in Nigeria was mainly due to poor pedagogical approaches used by teachers (Bot & Caleb, 2014) who rarely attend to learners' needs, but have high expectations for them (Du Toit-Brits, 2019). This has implications for learning processes, in that learners whose learning needs are thwarted or not met are likely to under-perform, develop poor attitudes, and demonstrate a lack of trust in their abilities (Okafor & Anaduaka, 2013; Walton, 2011). Learners' doubts about their abilities (poor self-efficacy) have been found to be part of the explanatory factors contributing to mathematics phobia, anxiety, and poor performances (Bonne & Lawes, 2016; Mutodi & Ngirande, 2014; Pagtulon-an & Tan, 2018; Spaniol, 2017).

In addition, the procedural nature of mathematics (Ghazali & Zakaria, 2011; Rittle-Johnson & Schneider, 2015) demands that learners' individual needs be met at each teaching scenario. The reason for this is that once a learner lacks the prerequisite knowledge and resources for given content, it will be difficult for the same learner to progress with others in the class as the levels of the tasks increase in difficulty. Failure to progress in this respect could make the learner develop poor maths self-efficacy, a situation where learners doubt their abilities to succeed in learning mathematics (Ogunmakin & Akomolafe, 2013). For learners' mastery in mathematics, the high self-efficacy of both the learners and the teacher is fundamental (Gökdağ Baltaoğlu & Güven, 2019). Learners who have low self-efficacy in mathematics often find it difficult to persist in learning the subject and so cannot achieve success.

On the other hand, self-efficacy is anchored on prior experiences of success or failure. Bandura (1986) found that self-efficacy is a product of four sources including previous performances, vicarious experiences, verbal persuasion, and physiological states. This indicates that PA in mathematics could inform the learners' beliefs in themselves when it comes to mathematics. Thus, in heterogeneous classrooms, a good number of learners may develop poor self-efficacy in mathematics due to past experiences of poor achievements (Prabawanto, 2018). The negative influences of these get more severe as learners progress to higher grades and learning experiences get more difficult. By the time they get to high school, those who have not developed high MSE find it difficult to learn complex mathematics topics. This could explain why the majority of topics that learners in Nigeria fail in the West African Examination Council (WAEC) examinations come from the SSII curriculum (WAEC, 2013, 2014). In this study we covered some of those topics included in the SSII curriculum, such as geometry and trigonometry, algebraic processes (quadratic equations) and numeration. Getting learners to understand these topics puts greater demands on SSII mathematics teachers, not only to teach the content but also to make efforts to address issues around learners developing a strong sense of competence in mathematics/MSE.

To address these issues, teachers need to assist learners – specifically at their individual levels of knowledge, interests, and learning styles (Florian & Black-Hawkins, 2011; Gökdağ Baltaoğlu & Güven, 2019). Regrettably, research shows that the majority of the teachers in Nigeria teach the whole class using a conventional approach which is largely a lecture method (Agwagah, 2013). The conventional lecture approach has been found wanting in teaching all learners the same way, at the same level and using the same materials irrespective of the diversity of the learners (Achuonye, 2015; Agwagah, 2013). Such methods have been proven inadequate for teaching mathematics in inclusive classrooms (where differences in abilities, learning styles and choices identify individual learners) (Agwagah, 2013). In order to raise learners' MSE, there is a need to adopt a pedagogical methodology that attends to learners' diverse needs and builds on their previous knowledge (Kay & Kibble, 2016; Kee, 2013) so that they can progress optimally.

DI (Tomlinson, CA 1999) is a learning approach aimed at creating a flexible yet organised classroom environment for meeting learners' needs and enabling all learners to build competence in inclusive education settings, where diversity accommodates the teaching-learning process (Landrum & McDuffie, 2010; Walton, 2017). In DI, teachers proactively adjust teaching and learning methods to accommodate each learner's learning needs and preferences in order to achieve his or her optimum growth as a learner (Landrum & McDuffie, 2010; Thakur, 2014; Tomlinson, C 2005; Tomlinson, CA 1999, 2001; Walton, 2017). A major strength of DI, in relation to self-efficacy development, is that through ongoing assessment, it taps into individual learner's knowledge levels, interests, and preferences (Landrum & McDuffie, 2010; Thakur, 2014;Tomlinson, C 2005; Walton, 2017). The positive effects of DI on achievement have been established across learner populations and their subject areas – especially in inclusive learning settings where the learner enrolment is not strictly informed by abilities (Abbas & Abdurrahman, 2015; Chamberlin & Powers, 2010; Flaherty & Hackler, 2010; Kreitzer, 2016; Meyad, Roslan, Abdullah & HajiMaming, 2014; Thakur, 2014). Florian and Black-Hawkins (2011) identified that DI was an effective inclusive pedagogy for attending the needs of special education children in inclusive classrooms. However, it is not clear whether DI impacts directly on learners' sense of confidence (self-efficacy) in that it enables them to set and achieve goals in mathematics.

Furthermore, there is a gap in the literature regarding whether DI could moderate the impact of PA on the self-efficacy of learners who consistently perform poorly in mathematics. Existing evidence suggests that the level of PA (high or low) can have a lasting influence on the learners' self-efficacy (Bandura, 1986; De Fátima Goulão, 2014; McCoach & Siegle, 2001; Schöber, Schütte, Köller, McElvany & Gebauer, 2018; Siegle, 2014; Tosun, 2009; Woolfolk, 2011). It could also bring about disparity in how learners benefit from a given teaching method (Fakayode, 2000; Mbam, 2010). If these are implied, meeting the needs of learners who present with consistent failure or poor performance in mathematics, such as learners with dyscalculia (a learning disability that impedes an individual's ability to represent and process numerical magnitude at an appropriate age level) may be more critical. Evidence-based studies acknowledge that children with dyscalculia constitute about 5 to 14% of the learner population (Fuchs, Fuchs & Compton, 2012; Kaufmann & Von Aster, 2012; Plerou, 2014). These ones are in a vicious circle of poor MSE and poor achievement in mathematics and need special approaches to raise their MSE so that they can progress with others in mathematics learning.

With this intervention we sought to determine whether DI would improve the MSE of learners in a mixed-ability classroom and whether DI moderates the negative effects of poor PA on the MSE of learners with dyscalculia and low and high achievers in mathematics. The hypothesis held at commencement of the process was that after the implementation of DI in mathematics teaching and learning for a whole term, learner's would improve significantly and those with dyscalculia would also have significant gains in MSE.

## Literature Review

### *Mathematics self-efficacy*

Self-efficacy belief can be defined as a personal judgment of one's capabilities to organise and execute courses of action to attain designated goals (Bandura, 1986; Gökdağ Baltaoğlu & Güven, 2019; Woolfolk, 2011). These predictions go a long way in determining the degree of one's success or failure in mathematics. An individual's expectations for success or failure at a particular task are influenced by such individual's self-efficacy (Bandura, 1986; Woolfolk, 2011). Hence, ones' self-efficacy in a given task or area represents one's conviction that one can successfully execute behaviour required to produce the desired outcomes in such a domain or endeavour (Rosen, Carrier & Cheever, 2010). A mathematics learner is said to have high self-efficacy in mathematics when such a learner has the conviction that they can set goals and accomplish them in the course of learning mathematics (Gökdağ Baltaoğlu & Güven, 2019; Woolfolk, 2011). On the other hand, low self-efficacy is indicated when learners do not believe that they can succeed in mathematics tasks because of a lack of ability. MSE affects mathematics performance, including mathematics achievement (ability to do well in solving mathematics problems) and maths literacy (ability to use mathematics knowledge in solving daily problems) (Cheema, 2018; Liu & Koirala, 2009).

Bandura's social cognitive theory (Bandura, 1986) asserts that self-efficacy differences underlie individual differences in beliefs, assumptions, implicit theories, and worldview in relation to oneself. Self-efficacy is both a domain-general (global) (Schöber et al., 2018) and/or domain-specific construct (McConney & Perry, 2010) that has been identified as core to learning traits such as persistence (Woolfolk, 2011), motivation (Bandura, 1986; Skaalvik, Federici & Klassen, 2015), attitude (Azar & Mahmoudi, 2014; Han, Liou-Mark, Yu & Zeng, 2015), problem solving (Gökdağ Baltaoğlu & Güven, 2019; Pajares & Miller, 1997), and career decision-making (Betz & Hackett, 1983). Self-efficacy has been found to be a very important tool for learning, given its reciprocal relationship with achievement (Gökdağ Baltaoğlu & Güven, 2019). Hence, learners who have low MSE are vulnerable to under-performance in mathematics, notwithstanding their abilities (Bandura, 1986; Schöber et al., 2018).

### *Dyscalculia*

Developmental dyscalculia (DD) is one of the learning problems that challenge learners of mathematics (Monei & Pedro, 2017; Williams, A 2013). It is a condition where learners have issues developing mathematics-related and arithmetical skills (Gillum, 2012; Rajkumar & Hema, 2017). Dyscalculia is a spectrum of difficulties in learning maths, because of the heterogeneity of learners and the constellation of skills that mathematics requires of those learners (Zhou & Cheng, 2015). The learners may also have poor number sense and not understand maths concepts like "greater than" and "less than." They may also struggle with remembering phone numbers or keeping track of scores when they are playing sports. DD has been referred to as number blindness, mathematical disability, arithmetic learning disability, number fact disorder and psychological difficulties in mathematics (Doyle, 2010; Gupta, 2014).

Apart from poor performances in mathematics, dyscalculia is symptomised in counting out mathematics solutions with fingers when it is not age-appropriate; inability to recall basic mathematics facts; inability to link numbers and symbols to quantities and directions; and difficulties recognising patterns and sequencing numbers at an early school age (Doyle, 2010). In secondary school, DD severely impedes academic progress or daily living. At this stage it may manifest in difficulties recognising, reading, writing or conceptualising numbers, understanding numerical or mathematical concepts and their interrelationships (Doyle, 2010; Gupta, 2014). Difficulty with numerical operations, difficulties with understanding the systems that rely on this fundamental understanding, such as time, money, direction, and more abstract mathematical, symbolic, and graphical representations could also depict DD at secondary school age (Doyle, 2010; Gupta, 2014). Other complex disabilities may include poor language of mathematics, and poor understanding of relationships between numbers (Butterworth, 2009). DD, like other learning disabilities, is based on malfunctioning of the brain, poor teaching, and environmental deprivation (Butterworth, 2009; Doyle, 2010).

Irrespective of the source of DD, learners affected by such struggle with maths performance (Henderson, 2012; Nfon, 2016) informs their maths identities (Heyd-Metzuyanim, 2013). These challenges keep the learners in a cycle of consistent poor achievement in mathematics, which can make learners with dyscalculia feel anxious about having to do maths-related tasks (Nfon, 2016; Rajkumar & Hema, 2017). They are more vulnerable to poor MSE leading to high mathematics anxiety (Nfon, 2016; Rubinsten & Tannock, 2010), and meeting their needs in a whole-class maths instruction situation could be quite challenging (Henderson, 2012; Heyd-Metzuyanim, 2013).

Poor achievement has a psychological impact on learners with dyscalculia, which accounts for their low academic self-concept, low self-efficacy, low self-motivation, low goal-valuation and a more negative attitude towards school and the teacher than the high achievers (Siegle, 2014). High achievers and low achievers differ in both their motivational patterns and their academic self-perceptions and sometimes cognitive development (Siegle, 2014). Consequently, studies have outlined the need for effective school-based interventions for individuals with dyscalculia (Gifford & Rockliffe, 2012; Monei & Pedro, 2017). The transactional relationship between poor PA and the self-efficacy of learners with and without dyscalculia is shown in Figure 1.

*Differentiated instruction*

According to CA Tomlinson (2001), during DI the teacher can challenge all the learners, irrespective of their Zone of Proximal Development (ZPD) or multiple intelligences, by providing materials and tasks on the standard at varying degrees of scaffolding through multiple instructional groups, and with time variation. Tomlinson's work was based on the idea of Gardner (1983) and Vygotsky (1978). Vygotsky (1978) believes that learners learn more when they are provided with tasks that are slightly beyond their current point of mastery, known as the ZPD. On the other hand, Gardner (1983) believes that intelligence varies from person to person and that eight types of intelligence exists: visual/spacial, verbal/linguistic, interpersonal, intrapersonal, logical/mathematic, musical, bodily kinaesthetic and naturalistic intelligences. CA Tomlinson (2001) built a framework that enabled the teacher to tap into learners' ZPD and characteristic preferences. To differentiate instruction, the teacher flexibly adjusts the content, process, product and learning environment to suit individual learner's prior knowledge, interests, and learning styles (Gentry, Sallie & Sanders, 2013; Tomlinson, CA 2001). In order to differentiate through content, teachers design activities for diverse groups of learners in a hierarchy of complexities (Algozzine & Anderson, 2007; Nunley, 2003) so that learners build on their different mastery/readiness levels.

Through the differentiating process, the teacher offers diverse ways in which learners can access the curriculum (Thakur, 2014; Walton, 2017). For instance, at the point of introducing a topic in a classroom, some learners may be unfamiliar with the concepts of the lesson, some may have partial mastery of the content or display mistaken ideas about the content, and others may show mastery of the content before the lesson. A teacher who differentiates instruction targets all learners in groups. To differentiate through the process, the teacher diversifies presentation of the content in a way that will appeal to diverse learners' learning styles. For instance, some learners may prefer to read about the topic while others may require practise in reading. Some learners may prefer to listen while others may need practise in listening and others may acquire knowledge by manipulating objects associated with the content (tactile) (Nunley, 2003).

Differentiating by-product involves offering the learners various ways to demonstrate what they have learned from the lesson unit (Algozzine & Anderson, 2007). According to Algozzine and Anderson, tests, projects, assignments and all kinds of evaluations can be given, provided they fall under the learners' level of educational standard in respect of the curriculum. All these can be put in place using menu unit sheets, choice boards or open-ended lists of final product options (Nunley, 2003). Finally, the learning environment can be differentiated by taking into consideration learners' specific characteristics and learning styles in physical classroom arrangements (Gentry et al., 2013). Based on that, the teacher provides varieties of sitting arrangements and learning materials for the learners to learn according to their different styles. DI is diversity-friendly, peculiarity-oriented and interest-sensitive as well as content-driven and activity-based.

In a mathematics DI lesson plan, the major steps in differentiation, as itemised by Good (2006), are built into mathematics instruction. These include: conducting pre-assessment on the learners to determine their level of readiness, interest, and learning styles; using the result of the pre-assessment to group the learners according to the level of guidance and scaffolding needed, their learning styles and preferences; anchor learning experiences for the whole group through whole-group instruction; providing each group with appropriate learning experiences which they engage in based on their needs and prior knowledge, and giving them the time to work in their groups (Florian & Black-Hawkins, 2011; Walton, 2017). Sometimes, according to their preferences, revise learning experiences for the whole group using works from those groups that exemplify an understanding of the topic and finally conduct assessment based on the same major concepts.

The efficacy of DI has been extensively documented in literature. For instance, Meyad et al. (2014) explored the effects of differentiated learning methods on learners' achievement in writing skills in learning Arabic as a foreign language in Malaysia and found positive effects of DI on learners' achievement. Abbas and Abdurrahman (2015) found DI fit for understanding middle school science concepts. Chamberlin and Powers (2010) also found that DI enhances understanding of mathematics among college students. Many other empirical works have demonstrated the effectiveness of DI in teaching in inclusive classrooms (Chamberlin & Powers, 2010; Thakur, 2014; Tomlinson, C 2005; Tomlinson, CA 1999, 2001; Westwood, 2001). When mathematics instruction is differentiated, it is likely that the learners will understand more, and achieve more (Chamberlin & Powers, 2010; Flaherty & Hackler, 2010; Meyad et al., 2014). The conceptual representation of the effect of DI on the self-efficacy of learners with and without dyscalculia is shown in Figure 1.

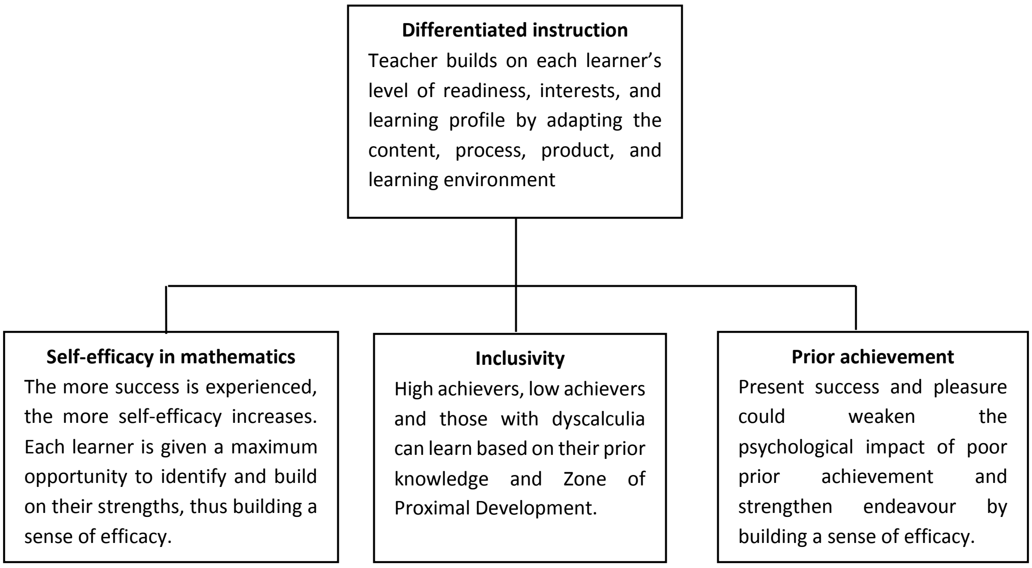


**Figure 1** The conceptual framework

## Method

### Ethical Considerations

The teachers in the study gave written consent declaring their interest in participating in the study. Learners were assured of the anonymous analysis and presentation of the findings. Identifying learners' PA levels was accomplished by giving them identification numbers based on their serial numbers in the school records. Learners were thus not labelled based on their achievement level. Teachers in the control group (CG) were given DI training after the study.

### Participants

Participants in the study included 158 (67 male and 91 female) SSII learners and four SSII maths teachers (three males and one female) drawn from four coeducational secondary schools in the Nsukka Education Zone, Enugu State, Nigeria. The authors conducted a pre-survey screening on SSII learners in all 19 mixed secondary schools in the area, using learners' MSE scale. Data collected in the pre-survey were subjected to descriptive statistics in order to identify the schools with learners of the lowest level of self-efficacy. Regrettably, 84.2% (16 schools) had low mean scores, showing a general low MSE among learners in the area. However, four schools with the lowest mean scores were purposively included in the study. The four schools selected were assigned to experimental and control conditions using a simple random sampling technique. In each of the four schools, one intact class was randomly selected for the study. However, the teachers were not restricted from differentiating instruction for other classes.

### Measures

The Mathematics Self-efficacy Scale (MSES) was used to measure learners' self-efficacy in mathematics before and after the DI intervention. MSES consists of 18 items which the researchers adapted from the standardised self-efficacy scale developed by Schwarzer and Jerusalem (2010).

Schwarzer and Jerusalem’s (2010) self-efficacy scale consists of 49 items of a four-point scale measuring general self-efficacy with a reliability coefficient of 0.72. Eighteen out of the 49 items of the instrument were adapted by selecting the appropriate items and recasting them to reflect self-efficacy in mathematics. The items were made up of a four-point response scale of Strongly Agreed (SA), Agreed (A), Disagreed (D) and Strongly Disagreed (SD). This included both positively and negatively worded items. Positively worded items were marked as follows: SA = 4 points, A = 3 points, D = 2 points and SD = 1 point, which was reversed for the negatively worded items. The internal consistency of MSES was calculated using Cronbach’s Alpha statistic which resulted in an α-value = 0.89.

A Short Developmental Dyscalculia Index (SDDI) was used to further augment mathematics PA in identifying learners with DD. The instrument consists of five short questions to which the learners responded orally during semi-structured interviews. The items measured whether the learner 1) Avoids answering maths-related questions during day-to-day conversations; 2) Has trouble estimating how much something will cost or how long a trip will take; 3) Cannot remember friends’ or parents’ phone numbers or addresses; 4) Uses a calculator for basic maths facts; 5) Is frequently late for classes. The learners attributing three or more of these items self-confirmed the presence of dyscalculia.

### Training Programme

A 5-day training workshop was conducted with follow-ups for two of the four SSII mathematics teachers in the four sample schools, who were teachers in the DI group. The 5-day programme was necessary to up-skill the teachers with DI and motivate them to invest their efforts towards meeting all learners. The training workshop also helped the researchers to build on teachers’ self-efficacy in implementing DI as studies highlight this as a major hinderance in the use of DI (Ekstam, Linnanmäki & Aunio, 2017; Suprayogi, Valcke & Godwin, 2017). The workshop was held 2 weeks before resumption of the first term of the 2016/2017 academic session. To guide the training, a training package was developed, which was utilised for 3 hours each day for 5 days. The training was aimed at educating the teachers about the concept of DI, the classroom implications of the teaching strategy, and the activities of the teacher during DI. The training sessions were guided by the DI manual developed by Onyishi (2017) to facilitate easy access to the workshop information. Session activities were as follows:

Day 1: Familiarisation with the teachers, sharing experiences with the teachers on their favourite teaching approaches, introduction of DI including definition and overview.

Day 2: Elements of DI were discussed, including differentiating by content (what the learners learn), process (different ways to approach learning), product (how the learners show what they have learnt) and environment (classroom condition). Explicit discussions were held on specific practices associated with each element. Bases for DI were also discussed, including readiness, interest, and learning styles.

Day 3: DI strategies were discussed, such as jigsaw, goal-setting, ongoing and formative assessment, compacting, respectful tasks, flexible grouping, tiered assignments, learning contracts, teaching-up, et cetera. All these were discussed in detail in the training manual. An interactive session was also held with the teachers on the concepts discussed and how they could bring these to bear in their mathematics class.

Day 4: In collaboration with the teachers, the selection of learner-oriented teaching materials was discussed in detail. The researchers drew from the topics that were to be covered to explicate the materials and methods in each case. The participants were assigned to develop a framework for DI in two of the topics to be covered during the term. These included three broad topics which included geometry and trigonometry 1 & 2 (chord properties and circle theorems); algebraic processes 1 (quadratic equations) and number numeration 2 (approximations) as stipulated in the SSII curriculum, using *New General Mathematics* (a standard mathematics textbook widely used in the area).

Day 5: Discussion and collaboration to develop a comprehensive framework of DI strategies continued. We collated ideas, compared the developed whole-term DI plans on the topics listed above on Day 4. The researchers and the teachers/research assistants checked coverage of the curriculum objectives of each topic and the extent to which the lesson plans were differentiated. For instance, it was ensured that the plan would take care of learners differences by i) following different formats; ii) varying learners tasks in complexity and perspectives; iii) planning for on-going assessment; providing learning material; iv) making provision for flexible grouping.

Follow up: During the follow-up exercise, interaction sessions were undertaken to validate the teachers’ preparation to implement DI. The flexibility of DI was also further discussed. Each teacher exemplified the skills learned from the DI training workshop.

Financial reinforcement was offered to the teachers. This was to cover their transport and refreshments during the 5-day training. The financial support was also meant to assist the teachers in buying some local materials that could help them diversify classroom experiences. This was necessitated by the problem of a lack of materials identified by the teachers. So, the financial support had positive implications for teachers' commitment and compliance to the package developed for the study throughout the research period.

### Procedure

The researchers obtained written permission from the Educational Foundation Department at the University of Nigeria, Nsukka, to embark on the study. Consent was also obtained from the supervising principal of the Nsukka Education Zonal Office in Enugu State, Nigeria. The researchers took the written certification to all the secondary school principals whose schools would take part in the screening exercise (see the sampling session). Thereafter, all the maths teachers in the sampled schools were notified about the workshop and subsequent participation in the research. They held their first meeting to familiarise themselves with the schedule of the workshop. The workshop itself then took place during the long vacation, 2 weeks before school resumed, as discussed above in the section on the training programme.

During resumption week, the researchers, with the help of the teachers (research assistants), collected learners' achievement histories from the school records. This informed the grouping of the participants into high-achieving and low-achieving learners, and learners with dyscalculia. Learners who consistently scored 60% and above in the three consecutive school terms were classified as high achievers. All those who scored between 40% and 59% were regarded as low achievers. Learners who consistently scored less than 40% were identified as being at risk of DD. Learners were further subjected to additional criteria for DD including the teachers confirming that such learners struggled abnormally in learning mathematics; ii) meeting the requirements for dyscalculia assessment (Kaufmann & Von Aster, 2012) in informal semi-structured interviews with five questions on indicators of dyscalculia in daily experiences as stated in the instrument session. Based on these results, eight learners met the criteria for DD, 95 learners were classified as low-achievers and 55 learners as high achievers. However, the learners were not informed about the grouping to avoid the psychological effects of labelling. For the learners' demographic data, see Table 1.

**Table 1** Learner's demographic variables

| Variable | Category | Experimental *n* (%) | Control *n* (%) | Total *n* (%) |
|---|---|---|---|---|
| Gender | Male | 33 (20.89%) | 34 (21.51%) | 67 (42.41%) |
| | Female | 47 (29.75%) | 44 (27.84%) | 91 (57.59%) |
| | Total | 80 (50.64%) | 78 (49.36%) | 158 (100%) |
| Prior achievement | High | 21 (13.29%) | 34 (21.51%) | 55 (34.81%) |
| | Low | 54 (34.18%) | 41 (25.95%) | 95 (60.13%) |
| | DD | 5 (3.16%) | 3 (1.90%) | 8 (5.06%) |
| | Total | 80 (50.63%) | 78 (49.36%) | 158 (100%) |

With the teachers' assistance, baseline data (pre-test) were collected using MSES in both the experimental and control groups. After the pre-test, learners in the experimental group (EG) were informed that they would be adopting a teaching-learning approach where they would be fully involved in the selection of materials developing learning goals and overall learning processes. The teacher trainees implemented DI in teaching mathematics throughout the first term which lasted for a period of 12 weeks, while those in the CG had their normal mathematics lessons guided by the teachers' discretion. The researchers visited each school three times every week to guide and monitor progress. It was more like collaborative teaching.

During the revision week, before the commencement of the school examination, the researchers and the research assistants administered a post-test to all the learner participants. All the learners who took part in the pre-test also completed the MSES during the post-intervention evaluation. Data collected during pre- and post-intervention evaluations were subjected to analysis using Statistical Package for the Social Sciences (SPSS) version 23.00. Figure 2 shows the procedure and data collection for the study.

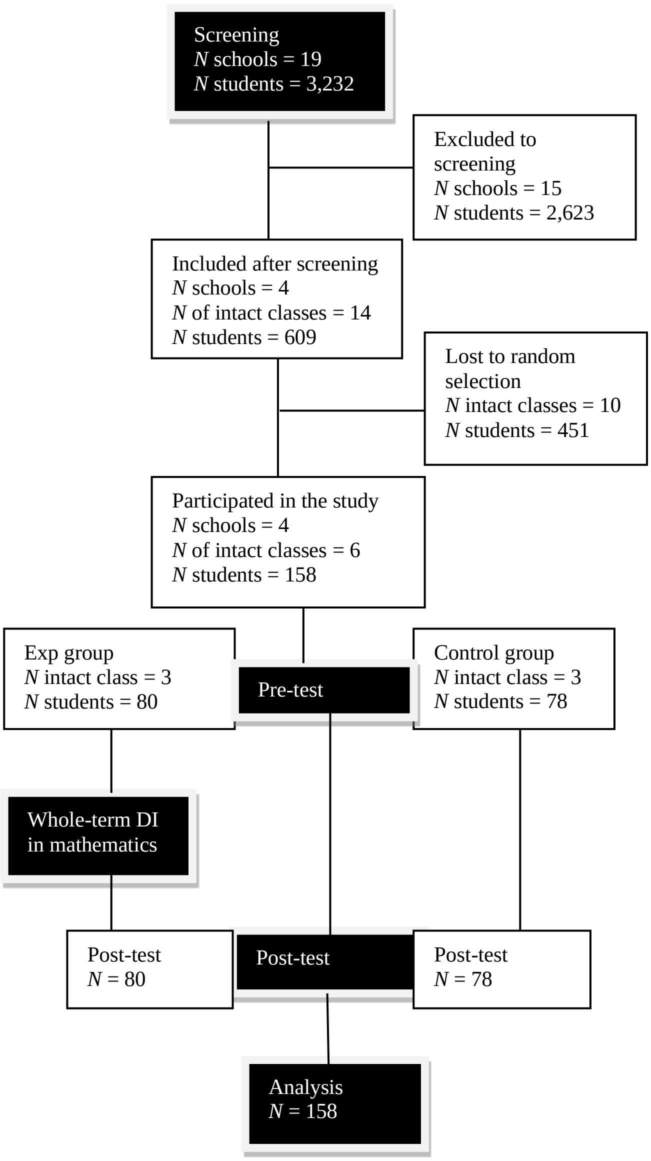


**Figure 2** Sampling, experimental and data collection procedure

## Design

A quasi-experimental research design was used for this study. This is a compromised experimental design applied where the random selection and assignment of the subjects to experimental and control groups are quite impracticable (Cohen, Manion & Morrison, 2011). Quantitative data were collected during pre-test and post-test evaluations and analysed using ANCOVA.

**Table 2** Pre-test–Post-test mean mathematics self-efficacy scores and standard deviation of learners

| Method | *N* | Pre-test | | Post-test | | Mean gain |
|---|---|---|---|---|---|---|
| | | *M* | *SD* | *M* | *SD* | |
| Treatment | 80 | 37.91 | 9.34 | 73.45 | 8.63 | 43.72 |
| Control | 78 | 36.71 | 8.55 | 39.59 | 1.77 | 1.85 |
| Total | 158 | 37.31 | 8.94 | 56.52 | 2.46 | 24.04 |

Table 2 shows that, at baseline (pre-test), both the EG and the CG had low mean MSE scores (experimental [exp.] = 37.91±9.34; control [cont.] = 36.71±8.55). At the post-test mean MSE score of learners in the EG increased significantly (73.45 ±8.63) compared to those in the CG (39.59±1.77). The EG had higher mean gain scores (43.72) compared to those in the CG (1.85). The moderate value of standard deviation (9.34 and 8.63 respectively) in the pre-test and post-test of the EG was indicative that individual mean scores were clustered around the mean. In the CG, their standard deviation during the pre-test was 8.55 while in the post-test, it was 1.77, showing that their individual scores were more clustered around the mean in the post-test than the pre-test. These results add to the validity of the mean scores in both the pre- and post-tests.

To test the significance of the main effect of DI on MSE, data were subjected to ANCOVA (see Table 3). Table 3 indicates that DI led to a significant improvement in the MSE of learners in the EG ($F$ = 446.284; $p$ = .000). This supports our hypothesis of significant improvement of MSE scores of learners after a whole term of DI in mathematics.

**Table 3** Summary of the two-way analysis of covariance of learners on the Mathematics Self-efficacy Scale

| Source | Type III *SS* | *df* | *MS* | *F* | *p* |
|---|---|---|---|---|---|
| Corrected model | 74072.493 | 4 | 18518.123 | 136.170 | .000 |
| Intercept | 16350.812 | 1 | 16350.812 | 120.233 | .000 |
| SEpre | 567.555 | 1 | 567.555 | 4.173 | .043 |
| Method | 60691.102 | 1 | 60691.102 | 446.284 | .000 |
| Prior achievement | 976.340 | 1 | 976.340 | 7.179 | .008 |
| Method * Prior achievement | 3648.993 | 1 | 3648.993 | 26.832 | .000 |
| Error | 20806.804 | 153 | 135.992 | | |
| Total | 577571.000 | 158 | | | |
| Corrected total | 94879.297 | 157 | | | |

*Note.* SEpre = Self-efficacy pre-test; Method-Differentiated instruction and lecture method; Method * Prior Achievement – interaction effect of method and prior achievement.

We further sought to determine the extent to which the MSE of learners with dyscalculia had improved. Controlling for the method (see Method * Prior achievement in Table 3), prior achievement had a significant impact on the learners' MSE ($F$ = 7.179; $p$ = .008).

**Table 4** Interaction effect of teaching methods and prior achievement on learners' mathematics self-efficacy

| Prior achievement | Groups | *N* | Pre-test | Post-test | Mean gain | *F* | *p* |
|---|---|---|---|---|---|---|---|
| | | | *M*±*SD* | *M*±*SD* | | | |
| High | Exp. | 21 | 64.72±8.82 | 75.33±9.67 | 10.61 | 123.24 | .001 |
| | Cont. | 34 | 61.52±5.52 | 63.91±17.43 | 2.39 | 1.136 | .569 |
| | Total | 55 | 63.12±7.17 | 69.62±13.55 | | | |
| Low | Exp. | 54 | 26.31±11.65 | 75.19±11.81 | 48.88 | 144.21 | .000 |
| | Cont. | 41 | 28.69±5.80 | 29.85±8.56 | 1.16 | .004 | .813 |
| | Total | 95 | 28.50±6.73 | 51.52±6.73 | | | |
| Dyscalculia | Exp. | 5 | 22.71±10.00 | 69.84±8.03 | 47.13 | 568.09 | .000 |
| | Cont. | 3 | 21.93±7.22 | 23.01±7.33 | 1.08 | .916 | .733 |
| | Total | 8 | 22.32±8.61 | 46.42±7.68 | | | |

We tried to determine whether DI bridged the gap in MSE among high achievers, low achievers and those with DD. Thus, data were analysed based on the interaction effect of DI and PA on MSE (see Table 4). At pre-test, high achievers in mathematics in the EG obtained a higher mean MSE score (64.72±8.82), over both low-achievers (26.31±11.65) and those with DD (22.71±10.00). Interestingly, MSE improved greatly in the three sub-groups at post-intervention evaluation: high achievers (75.33±9.67); low achievers (75.19±11.81) and those with DD (69.84±8.03). In the CG, the high-achievers had a much higher pre-test mean MSE score (61.52±5.52) than low achievers (28.69±5.80) and those with DD (21.93±7.22).

Considering the mean gain in MSE across pre-test and post-test, Table 4 demonstrates that all the learners' sets (high achievers' mean gain 10.61; $F$ = 123.24; $p$ = .001; Low achievers' mean gain = 48.88; $F$ = 144.21; $p$ = .000 and learners with dyscalculia's mean gain = 47.13; $F$ = 569.01; $p$ = .000) in the EG improved significantly compared to their counterparts in the CG who had no significant change in MSE scores across pre-test and post-test (high achievers' mean gain = 2.39; $F$ = 1.136; $p$ = .569; low achievers' mean gain = 1.16; $F$ = 0.04; $p$ = .813; dyscalculia mean gain = 1.08; $F$ = .916; $p$ = .733).

Comparing the pre-test mean differences between the high achievers' and low achievers' MSE in the EG, data indicated a significant difference (mean difference [MD] = 38.41; $p$ = .000) in favour of the high achievers. This mean difference was reduced considerably during the post-test (MD = 0.14; $p$ = .562). Further, the difference in MSE means of high-achieving learners and those with DD reduced significantly from MD = 39.59; $p$ = .000 at pre-test evaluation to MD = 5.49; $p$ = .03. These suggest that DI reduces limitations in MSE associated with PA. Compared to learners in the CG, all in the three learner subgroups in the EG reported considerable gains in mean MSE scores across pre-test and post-test.

## Discussion

The results of this study reveal that DI had a significantly positive effect on the MSE of learners. It was revealed that the MSE of the EG (who received DI) improved significantly over the CG (who did not receive DI). This result is in agreement with the earlier research findings of SM Tomlinson (2013) on the effect of DI on the MSE of learners who have experienced little success in mathematics. The result of the study show that using DI-inclusive classrooms improved learners' MSE. This finding is in discord with that of a quantitative study carried out by Scott (2012), in which the author concluded that DI did not have overall effectiveness at a significant level. The nonsignificant effect found by Scott (2012) could be a product shortcoming in the DI procedures employed by the researchers. Other earlier studies, however, did find positive effects of DI on learners' learning. For instance, Rojo (2013), in a study of 48 learners from two regular chemistry classes, showed that learners expressed a more positive attitude to their level of self-confidence in the learning after being exposed to DI. Other studies have also confirmed the effectiveness of DI in inclusive classrooms (Ogunkunle & Henrietta, 2014; Williams, KG 2012). The study also adds to all other empirical evidence supporting the effectiveness of DI on learning and teaching processes (Abbas & Abdurrahman, 2015; Chamberlin & Powers, 2010; Meyad et al., 2014; Thakur, 2014; Tomlinson, C 2005; Tomlinson, CA 1999, 2001; Westwood, 2001).

The ability of DI to enhance learners' MSE can be attributed to its distinctive and peculiar instructional approach which exposes the learners to learning content, learning process and assessment procedures which are appropriate to the individual learner's level of prior knowledge, interest and learning styles (Flaherty & Hackler, 2010; Tomlinson, C 2005; Tomlinson, CA 1999, 2001). DI also provides the learners with immediate and continuous feedback, and also tends to attend promptly to the learners' specific needs (Chamberlin & Powers, 2010). Such feedback helps to motivate learners to learn by prompt recognition of the learners' strengths and weaknesses with regard to the learning content and materials. This helps learners to improve their skills and experience a quantum of success needed for improved MSE. For instance, as the learners are presented with a task, they are guided to approach the materials from different angles based on what they already know. The teachers' disposition to recognise the learners' strengths and direct each group or individual through comments and questions as they try out the task, undoubtedly develops the learners' self-efficacy and enhances their mastery of the required skills.

Furthermore, explicating how to differentiate by content (what the learners learn), process (different ways to approach learning), product (how the learners show what they have learnt) and environment (classroom condition) with the teachers, using the training model could have also helped to draw teachers' attention to the intricacies that could build on both teachers' and learners' competences. Also, the DI training model helped the teachers to become familiar with specific DI strategies such as jigsaw, goal-setting, ongoing and formative assessment, compacting, respectful tasks, flexible grouping, tiered assignments, learning contracts, and teaching-up, which could have helped every learner to experience success. The initial training of the teacher was the basis of success throughout the term. It helped to draw the teachers' attention to what they would ordinarily overlook, such as using local materials (improvisation) to attend to learners' individual needs. This could be why prior studies in this field have consistently highlighted the importance of teachers' training in the use of DI (Ekstam et al., 2017; Gillespie Rouse & Kiuhara, 2017; Rachmawati et al., 2016; Spratt & Florian, 2013; Strogilos, 2018).

The findings of this study reveal that PA as a factor in the study had a significant influence on the learners' MSE. Generally, there was a significant difference in the self-efficacy of high-achieving and low-achieving learners, and learners with dyscalculia. This makes a significant contribution to existing literature confirming the link between self-efficacy and achievement, or what Bandura refers to as mastery experiences (Bandura, 1986; Cheema, 2018; Liu & Koirala, 2009). After the intervention, both high-achieving and low-achieving learners in the EG improved significantly in their MSE over those in the CG. This implies that as learners' MSE increases, so does their achievement and vice versa.

Low-achievement has a psychological impact on the low achievers, which accounts for their low academic self-concept, low self-efficacy, low self-motivation, low goal-valuation and negative attitude toward school and teachers compared to the high achievers (Siegle, 2014). Learners who have had a prolonged experience of low achievement in an area may consider their low achievement to be unchangeable; they expect to fail in the future, and they give up easily when confronted with difficult tasks or even avoid tasks in that domain. Unless interrupted by successful experiences and interventions, continued failure tends to confirm low expectations of achievement, which in turn keeps the learners in a vicious circle of low self-efficacy and poor performance. DI offers the necessary resources that help learners overcome the effect of prior failures on both low-achieving learners and learners with DD.

### Limitations of the Study

This was not without some shortcomings that could affect the generalisability of the findings. Firstly, the result of this study may have been influenced by teachers' levels of interest and commitment to integrating DI strategies into teaching during the lessons. Further studies in this area may consider the researcher disguising as a new mathematics teacher to self-implement DI over a period; action research. This could afford more insight into the actual effectiveness of DI in inclusive settings. Secondly, we did not measure the learners achievement due to DI. Further studies may consider exploring the effect on achievement. Given the relationship between self-efficacy and achievement, it is possible that DI could have improved learners' achievement significantly. Thirdly, we did not consider the effect of teachers' self-efficacy and competence. More studies are needed to explore those areas. Furthermore, the unique steps adopted to attend to the needs of learners with DD are not stated here. Further studies may be conducted to determine specific aspects of DI that are necessary to raise the self-efficacy of those with DD. Finally, we only used quantitative data. In future studies teachers' and learners' perceptions and experiences may be explored using qualitative data obtained through interviews and observation.

## Conclusion

It can thus be concluded that DI is an effective teaching approach for improving the MSE of learners with diverse individualities in an inclusive classroom setting. This conclusion is based on the findings of this study which reveal that using DI in teaching mathematics enhanced the learners' MSE over conventional (lecture) methods. PA has significant influence on the MSE of learners such that high-achieving learners have higher MSE than their low-achieving counterparts and those with dyscalculia. However, when DI was used in teaching mathematics in mixed-ability classrooms, learners' self-efficacy improved irrespective of PAs.

## Authors' Contributions

Charity N. Onyishi wrote the manuscript and provided data for the study. Maximus M. Sefotho provided material and supervised the investigation. Both authors reviewed the final manuscript.

## Notes

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## References


Abbas GA & Abdurrahman MS 2015. The effectiveness of differentiated instruction on students' geometric achievement in Kebbi state senior secondary schools, Nigeria. *International Journal of Scientific & Engineering Research*, 6(1). Available at https://www.ijser.org/paper/THE-EFFECTIVENESS-OF-DIFFERENTIATED-INSTRUCTION-ON-STUDENTS.html. Accessed 23 May 2017.

Achuonye KA 2015. Predominant teaching strategies in schools: Implications for curriculum implementation in mathematics, science and technology. *Educational Research and Reviews*, 10(15):2096–2103. https://doi.org/10.5897/ERR2015.2184

Adetoro RA 2014. Inclusive education in Nigeria—A myth or reality? *Creative Education*, 5(20):1777–1781. https://doi.org/10.4236/ce.2014.520198

Agunloye OO, Pollingue AB, Davou P& Osagie R 2011. Policy and practice of special education: Lessons and implications for education administration from two countries. *International Journal of Humanities and Social Science*, 1(9):90–95.

Agwagah U 2013. Improving the teaching of mathematics for attainment of seven point agenda: Implication for gender disparity. *ABACUS: The Journal of the Mathematical Association of Nigeria*, 38(1):111–121.

Algozzine B & Anderson KM 2007. Tips for teaching: Differentiating instruction to include all students. *Preventing School Failure: Alternative Education for Children and Youth*, 51(3):49–54. https://doi.org/10.3200/PSFL.51.3.49-54

Azar FS & Mahmoudi L 2014. Relationship between Mathematics, self-efficacy and students' performance in statistics: The meditational role of attitude toward Mathematics and Mathematics anxiety. *Journal of Educational Sciences & Psychology*,4(1):32–42. Available at https://www.proquest.com/docview/1746587015?pq-origsite=gscholar&fromopenview=true. Accessed 17 November 2021.

Bandura A 1986. *Social foundations of thought and action: A social cognitive theory*. Englewood Cliffs, NJ: Prentice-Hall.

Berman KM, Schultz RA & Weber CL 2012. A lack of awareness and emphasis in preservice teacher training: Preconceived beliefs about the gifted and talented. *Gifted Child Today*, 35(1):18–26. https://doi.org/10.1177/1076217511428307

Betz NE & Hackett G 1983. The relationship of mathematics self-efficacy expectations to the selection of science-based college majors. *Journal of Vocational Behavior*, 23(3):329–345. https://doi.org/10.1016/0001-8791(83)90046-5

Bonne L & Lawes E 2016. Assessing students' maths self-efficacy and achievement. *NZCER*, Set 2016(2):60–63. https://doi.org/10.18296/set.0048

Bot TD & Caleb ML 2014. A study on the quantity and quality of mathematics teachers in central Plateau state, Nigeria: Implications for national development in Nigeria. *Journal of Education and Practice*, 5(31):20–28. Available at https://irepos.unijos.edu.ng/jspui/bitstream/123456789/1448/1/A%20Study%20on%20Quantity%20and%20Quality%20of%20Mathematics%20Teachers%20in.pdf. Accessed 16 November 2021.

Butterworth B 2009. *Dyscalculia: Causes, identification, intervention and recognition*. Paper presented at

the Dyscalculia & Mathematics Learning Difficulties Inaugural Conference, London, England, 19 June.
Chamberlin M & Powers R 2010. The promise of differentiated instruction for enhancing the mathematical understandings of college students. *Teaching Mathematics and its Applications: An International Journal of the IMA*, 29(3):113–139. https://doi.org/10.1093/teamat/hrq006
Charema J 2010. Inclusive education in developing countries in the sub Saharan Africa: From theory to practice. *International Journal of Special Education*, 25(1):87–93. Available at https://files.eric.ed.gov/fulltext/EJ890569.pdf. Accessed 16 November 2021.
Cheema JR 2018. Effect of math-specific self-efficacy on math literacy: Evidence from a Greek survey. *Research in Education*, 102(1):13–36. https://doi.org/10.1177/0034523717741914
Cohen L, Manion L & Morrison K 2011. *Research methods in education* (7th ed). London, England: Routledge.
De Fátima Goulão M 2014. The relationship between self-efficacy and academic achievement in adults' learners. *Athens Journal of Education*, 1(3):237–246. https://doi.org/10.30958/aje.1-3-4
Doyle A 2010. *Dyscalculia and mathematical difficulties: Implications for transition to higher education in the Republic of Ireland*. Dublin, Ireland: University of Dublin Trinity College. Available at http://eprints.teachingandlearning.ie/3960/1/Doyle%202010%20%20Dyscalculia%20-%20symp1-1.pdf. Accessed 16 November 2021.
Du Toit-Brits C 2019. A focus on self-directed learning: The role that educators' expectations play in the enhancement of students' self-directedness. *South African Journal of Education*, 39(2):Art. #1645, 11 pages. https://doi.org/10.15700/saje.v39n2a1645
Ekstam U, Linnanmäki K & Aunio P 2017. The impact of teacher characteristics on educational differentiation practices in lower secondary mathematics instruction. *LUMAT: International Journal on Math, Science and Technology Education*, 5(1):41–60. https://doi.org/10.31129/LUMAT.5.1.253
Engelbrecht P, Oswald M & Forlin C 2006. Promoting the implementation of inclusive education in primary schools in South Africa. *British Journal of Special Education*, 33(3):121–129. https://doi.org/10.1111/j.1467-8578.2006.00427.x
Fakayode AF 2000. Creativity-locus of control achievement motivation and their relationship with the academic performance of senior secondary school science students. PhD thesis. Ilorin, Nigeria: University of Ilorin.
Flaherty S & Hackler R 2010. Exploring the effects of differentiated instruction and cooperative learning on the intrinsic motivational behaviors of elementary reading students. Chicago, IL: Saint Xavier University. Available at https://files.eric.ed.gov/fulltext/ED509195.pdf. Accessed 16 November 2021.
Florian L & Black-Hawkins L 2011. Exploring inclusive pedagogy. *British Educational Research Journal*, 37(5):813–828. https://doi.org/10.1080/01411926.2010.501096
Fuchs LS, Fuchs D & Compton DL 2012. The early prevention of mathematics difficulty: Its power and limitations. *Journal of Learning Disabilities*, 45(3):257–269. https://doi.org/101177/0022219412442167
Gardner H 1983. *Frames of mind: The theory of multiple intelligences*. New York, NY: Basic Books.
Gentry R, Sallie AP & Sanders CA 2013. *Differentiated instructional strategies to accommodate students with varying needs and learning styles*. Paper presented at the Urban Education Conference, Jackson, MS, 18–20 November. Available at https://files.eric.ed.gov/fulltext/ED545458.pdf. Accessed 20 November 2021.
Ghazali NHC & Zakaria E 2011. Students' procedural and conceptual understanding of mathematics. *Australian Journal of Basic and Applied Sciences*, 5(7):684–691. Available at https://www.researchgate.net/publication/278848275_Students'_procedural_and_conceptual_understanding_of_mathematics. Accessed 15 November 2021.
Gifford S & Rockliffe F 2012. Mathematics difficulties: Does one approach fit all? *Research in Mathematics Education*, 14(1):1–15. https://doi.org/10.1080/14794802.2012.657436
Gillespie Rouse A & Kiuhara SA 2017. SRSD in writing and professional development for teachers: Practice and promise for elementary and middle school students with learning disabilities [Special issue]. *Learning Disabilities Research & Practice*, 32(3):180–188. https://doi.org/10.1111/ldrp.12140
Gillum J 2012. Dyscalculia: Issues for practice in educational psychology. *Educational Psychology in Practice*, 28(3):287–297. https://doi.org/10.1080/02667363.2012.684344
Gökdağ Baltaoğlu M & Güven M 2019. Relationship between self-efficacy, learning strategies, and learning styles of teacher candidates (Anadolu University example). *South African Journal of Education*, 39(2):Art. #1579, 11 pages. https://doi.org/10.15700/saje.v39n2a1579
Good ME 2006. *Differentiated instruction: Principles and techniques for the elementary grades*. San Rafael, CA: Dominican University of California. Available at https://files.eric.ed.gov/fulltext/ED491580.pdf. Accessed 17 November 2021.
Gupta N 2014. *Dyscalculic co morbidity in secondary school going children*. Available at https://pdfs.semanticscholar.org/6336/5acd9a0e0227b997c066d7cb177070e441d6.pdf. Accessed 15 November 2021.
Han S, Liou-Mark J, Yu KT & Zeng S 2015. Self-efficacy and attitudes towards mathematics of undergraduates: A U.S. and Taiwan comparison. *Journal of Mathematics Education*, 8(1):1–15. Available at http://educationforatoz.net/images/Han_Spring_2015_.pdf. Accessed 15 November 2021.
Henderson A 2012. *Dyslexia, dyscalculia and mathematics: A practical guide* (2nd ed). London, England: Routledge.
Heyd-Metzuyanim E 2013. The co-construction of learning difficulties in mathematics—teacher–student interactions and their role in the development of a disabled mathematical identity.

*Educational Studies in Mathematics*, 83(3):341–368. https://doi.org/10.1007/s10649-012-9457-z
Hornby G 2011. Inclusive education for children with special education needs: A critique. *International Journal of Disability, Development and Education*, 58(3):321–329. https://doi.org/10.1080/1034912x.2011.598678
Kaufmann L & Von Aster M 2012. The diagnosis and management of dyscalculia. *Deutsches Ärzteblatt International*, 109(45):767–778. https://doi.org/10.3238/arztebl.2012.0767
Kay D & Kibble J 2016. Learning theories 101: Application to everyday teaching and scholarship. *Advances in Physiology Education*, 40(1):17–25. https://doi.org/10.1152/advan.00132.2015
Kee CE 2013. Faculty views of developmental math instruction at an urban community college: A critical pedagogy analysis. PhD dissertation. Ames, IA: Iowa State University. Available at https://www.proquest.com/docview/1415873128?fromopenview=true&pq-origsite=gscholar. Accessed 15 November 2021.
Kreitzer K 2016. Differentiation for all learners: Applying theory and practice so all children reach their potential. MAT dissertation. St Paul, MN: Hamline University. Available at https://digitalcommons.hamline.edu/cgi/viewcontent.cgi?referer=https://scholar.google.com/&httpsredir=1&article=5207&context=hse_all. Accessed 15 November 2021.
Landrum TJ & McDuffie KA 2010. Learning styles in the age of differentiated instruction. *Exceptionality*, 18(1):6–17. https://doi.org/10.1080/09362830903462441
Lingo AS, Barton-Arwood SM & Jolivette K 2011. Teachers working together: Improving learning outcomes in the inclusive classroom—practical strategies and examples. *TEACHING Exceptional Children*, 43(3):6–13. https://doi.org/10.1177/005991104300301
Liu X & Koirala H 2009. The effect of mathematics self-efficacy on mathematics achievement of high school students. In T Levine & H Marx (eds). *NERA Conference Proceedings 2009*. Storrs, CT: University of Connecticut. Available at https://opencommons.uconn.edu/cgi/viewcontent.cgi?article=1029&context=nera_2009. Accessed 17 November 2021.
Mbam GO 2010. Effect of active learning techniques on senior secondary mathematics students' performance in longitude and latitude problems in Abakaliki. MEd dissertation. Ilorin, Nigeria: University of Ilorin.
McCoach DB & Siegle D 2001. A comparison of high achievers' and low achievers' attitudes, perceptions, and motivations. *Academic Exchange*, 2:71–76.
McConney A & Perry LB 2010. Socioeconomic status, self-efficacy, and mathematics achievement in Australia: A secondary analysis. *Educational Research for Policy and Practice*, 9(2):77–91. https://doi.org/10.1007/s10671-010-9083-4
Meyad NA, Roslan S, Abdullah MC & HajiMaming P 2014. The effect of differentiated learning method on students' achievement in writing skills in learning Arabic as a foreign language. *International Journal of Research in Education Methodology*, 6(2):889–895. Available at https://pdfs.semanticscholar.org/89e3/2d8c5fd6b932ac7c67d08947b55103f25faf.pdf. Accessed 17 November 2021.
Monei T & Pedro A 2017. A systematic review of interventions for children presenting with dyscalculia in primary schools. *Educational Psychology in Practice*, 33(3):277–293. https://doi.org/10.1080/02667363.2017.1289076
Mupa P & Chinooneka TI 2015. Factors contributing to ineffective teaching and learning in primary schools: Why are schools in decadence? *Journal of Education and Practice*, 6(19):125–132. Available at https://files.eric.ed.gov/fulltext/EJ1079543.pdf. Accessed 20 November 2021.
Mutodi P & Ngirande H 2014. Exploring mathematics anxiety: Mathematics students' experiences. *Mediterranean Journal of Social Sciences*, 5(1):283–294. https://doi.org/10.5901/mjss.2014.v5n1p283
Nel N, Nel M & Hugo A (eds.) 2013. *Learner support in a diverse classroom: A guide for foundation, intermediate and senior phase teachers of language and mathematics*. Pretoria, South Africa: Van Schaik.
Nfon NF 2016. A survey of the mathematical problems (dyscalculia) confronting primary school pupils in Buea Municipality in the South West Region of Cameroon. *International Journal of Education and Research*, 4(4):437–450. Available at http://ww.w.ijern.com/journal/2016/April-2016/36.pdf. Accessed 15 November 2021.
Nunley KF 2003. Giving credit where credit is due. *Principal Leadership*, 3(9):26–29.
Ogunkunle RA & Henrietta OA 2014. Effect of differentiated instructional strategies on students' retention in geometry in FCT senior secondary schools, Abuja, Nigeria. *Global Journal of Educational Research*, 13(1):1–7. https://doi.org/10.4314/gjedr.v13i1.1
Ogunmakin AO & Akomolafe MJ 2013. Academic self-efficacy, locus of control and academic performance of secondary school students in Ondo State, Nigeria. *Mediterranean Journal of Social Sciences*,4(11):570–576. https://doi.org/10.5901/mjss.2013.v4n11p570
Okafor CF & Anaduaka US 2013. Nigerian school children and mathematics phobia: How the mathematics teacher can help. *American Journal of Educational Research*, 1(7):247–251. https://doi.org/10.12691/education-1-7-5
Onyishi CN 2017. Effect of differentiated instruction on students' self-efficacy, task-persistence and interest in mathematics. PhD thesis. Nsukka, Nigeria: University of Nigeria.
Pagtulon-an EA & Tan DA 2018. Students' mathematics performance and self-efficacy beliefs in a rich assessment tasks environment. *Asian Academic Research Journal of Multidisciplinary*, 5(2):54–64. Available at https://www.researchgate.net/publication/326653311_STUDENTS'_MATHEMATICS_PERFORMANCE_AND_SELF-EFFICACY_BELIEFS_IN_A_RICH_ASSESSMENT_TASKS_ENVIRONMENT. Accessed 14 November 2021.

Pajares F & Miller MD 1997. Mathematics self-efficacy and mathematical problem solving: Implications of using different forms of assessment.*The Journal of Experimental Education*, 65(3):213–228. https://doi.org/10.1080/00220973.1997.9943455

Plerou A 2014. Dealing with dyscalculia over time. In *Proceedings of the International Conference on Information Communication Technologies in Education*. Kos, Greece. https://doi.org/10.13140/2.1.4229.5681

Prabawanto S 2018. The enhancement of students' mathematical self-efficacy through teaching with metacognitive scaffolding approach. *Journal of Physics: Conference Series*, 1013:012135. https://doi.org/10.1088/1742-6596/1013/1/012135

Rachmawati MA, Nu'man TM, Widiasmara N & Wibisono S 2016. Differentiated instruction for special needs in inclusive schools: A preliminary study. *Procedia-Social and Behavioral Sciences*, 217:585–-593. https://doi.org/10.1016/j.sbspro.2016.02.053

Rajkumar R & Hema G 2017. Mathematics learning difficulties for school students: Problems and strategies. *Shanlax International Journal of Arts, Science and Humanities*, 5(4):183–190.

Rittle-Johnson B & Schneider M 2015. Developing conceptual and procedural knowledge of mathematics. In R Cohen Kadosh & A Dowker (eds). *The Oxford handbook of numerical cognition*. Oxford, England: Oxford University Press. https://doi.org/10.1093/oxfordhb/9780199642342.013.014

Rojo P 2013. Studying the effects of differentiated instruction in the science classroom. MS dissertation. Bozeman, MT: Montana State University. Available at https://scholarworks.montana.edu/xmlui/bitstream/handle/1/2825/RojoP0813.pdf?sequence=1&isAllowed=y. Accessed 14 November 2021.

Rosen LD, Carrier LM & Cheever NA 2010. *Rewired: Understanding the iGeneration and the way they learn*. New York, NY: Palgrave Macmillan.

Rubinsten O & Tannock R 2010. Mathematics anxiety in children with developmental dyscalculia. *Behavioral and Brain Functions*, 6(1):46. https://doi.org/10.1186/1744-9081-6-46

Schmitt C & Goebel V 2015. Experiences of high-ability high school students: A case study. *Journal for the Education of the Gifted*, 38(4):428–446. https://doi.org/10.1177/0162353215607325

Schöber C, Schütte K, Köller O, McElvany N & Gebauer MM 2018. Reciprocal effects between self-efficacy and achievement in mathematics and reading. *Learning and Individual Differences*, 63:1–11. https://doi.org/10.1016/j.lindif.2018.01.008

Schwarzer R & Jerusalem M 2010. The general self-efficacy scale (GES). *Anxiety, Stress, and Coping*, 12(1):329–345. Available at https://diabetes-psychologie.de/downloads/Beschreibung_GSE.pdf. Accessed 20 November 2021.

Schweisfurth M 2011. Learner-centred education in developing country contexts: From solution to problem? *International Journal of Educational Development*, 31(5):425–432. https://doi.org/10.1016/j.ijedudev.2011.03.005

Scott B 2012. The effectiveness of differentiated instruction in the elementary mathematics classroom. PhD dissertation. Muncie, IN: Ball State University. Available at https://www.proquest.com/docview/1017538121?pq-origsite=gscholar&fromopenview=true. Accessed 14 November 2021.

Siegle D 2014. Technology: Differentiating instruction by flipping the classroom. *Gifted Child Today*, 37(1):51–55. https://doi.org/10.1177/1076217513497579

Skaalvik EM, Federici RA & Klassen RM 2015. Mathematics achievement and self-efficacy: Relations with motivation for mathematics. *International Journal of Educational Research*, 72:129–136. https://doi.org/10.1016/j.ijer.2015.06.008

Spaniol SR 2017. Students' mathematics self-efficacy, anxiety, and course level at a community college. PhD dissertation. Minneapolis, MN: Walden University.

Spratt J & Florian L 2013. Applying the principles of inclusive pedagogy in initial teacher education: From university based course to classroom action. *Revista de Investigaciónen Educación*, 11(3):133–140.

Srivastava M, De Boer A & Pijl SJ 2015. Inclusive education in developing countries: A closer look at its implementation in the last 10 years. *Educational Review*, 67(2):179–195. https://doi.org/10.1080/00131911.2013.847061

Strogilos V 2018. The value of differentiated instruction in the inclusion of students with special needs/disabilities in mainstream schools. In AG Abdullah, J Foley, IGNA Suryaputra & A Hellman (eds). *SHS Web of Conferences* (Vol. 42). Paris, France: EDP Sciences. https://doi.org/10.1051/shsconf/20184200003

Suprayogi MN, Valcke M & Godwin R 2017. Teachers and their implementation of differentiated instruction in the classroom. *Teaching and Teacher Education*,67:291–301.

Thakur K 2014. Differentiated instruction in the inclusive classroom. *Research Journal of Educational Sciences*, 2(7):10–14. Available at http://www.isca.in/EDU_SCI/Archive/v2/i7/2.%20ISCA-RJEduS-2014-025.pdf. Accessed 14 November 2021.

Tomlinson C 2005. This issue: Differentiated instruction. *Theory into Practice*, 44(3):183–184. https://doi.org/10.1207/s15430421tip4403_1

Tomlinson CA 1999. Mapping a route toward a differentiated instruction. *Educational Leadership*, 57(1):12–16.

Tomlinson CA 2001. *How to differentiate instruction in mixed-ability classrooms* (2nd ed). Alexandria, VA: Association for Supervision and Curriculum Development (ASCD).

Tomlinson SM 2013. A study of differentiated instruction based on the SIOP model in Georgia classrooms. PhD dissertation. Minneapolis, MN: Capella University. Available at https://www.proquest.com/docview/1315766855?fromopenview=true&pq-origsite=gscholar. Accessed 21 November 2021.

Tosun T 2009. The impact of prior science course experience and achievement on the science teaching self-efficacy of preservice elementary teachers. *Journal of Elementary Science Education*, 12(2):21–31. https://doi.org/10.1007/BF03173597

United Nations Educational, Scientific and Cultural Organization 1994. *The Salamanca Statement and Framework for Action on Special Needs Education adopted by the World Conference on Special Needs Education: Access and Quality, Salamanca, Spain, 7-10 June 1994*. Paris, France: Author.

Verger A, Novelli M & Altinyelken HK (eds.) 2012. *Global education policy and international development: New agendas, issues and policies*. New York, NY: Bloomsbury Academic.

Vygotsky L 1978. *Mind in society: The development of higher psychological processes*. Cambridge, MA: Harvard University Press.

Walton E 2011. Getting inclusion right in South Africa. *Intervention in School and Clinic*,46(4):240–245. https://doi.org/10.1177/1053451210389033

Walton E 2017. Inclusive education in initial teacher education in South Africa: Practical or professional knowledge? *Journal of Education*, 67:101–128. https://doi.org/10.17159/2520-9868/i67a05

West African Examination Council 2013. *May/June 2013 West African senior school certificate examination: General resume of chief examiners' report*. Available at https://www.waecgh.org/uploads/examinersReport/2013/General%20Resume2.pdf. Accessed 20 November 2021.

West African Examination Council 2014. *Chief examiners' report on May/June school certificate examination*. Lagos, Nigeria: Lucky Star.

Westwood P 2001. Differentiation as a strategy for inclusive classroom practice: Some difficulties identified. *Australian Journal of Learning Difficulties*, 6(1):5–11. https://doi.org/10.1080/19404150109546651

Williams A 2013. A teacher's perspective of dyscalculia: Who counts? An interdisciplinary overview. *Australian Journal of Learning Difficulties*, 18(1):1–16. https://doi.org/10.1080/19404158.2012.727840

Williams KG 2012. The effect of differentiated instruction on standardized assessment performance of students in the middle school mathematics classroom. PhD dissertation. Lynchburg, VA: Liberty University. Available at https://digitalcommons.liberty.edu/cgi/viewcontent.cgi?referer=https://scholar.google.com/&httpsredir=1&article=1609&context=doctoral. Accessed 13 November 2021.

Woolfolk A 2011. *Educational psychology. Active learning edition* (3rd ed). Boston, MA: Allyn & Bacon.

Zhou X & Cheng D 2015. When and why numerosity processing is associated with developmental dyscalculia. In S Chinn (ed). *The Routledge international handbook of dyscalculia and mathematical learning difficulties*. New York, NY: Routledge.