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# Differentiated Instruction in Improving Students' Task-persistence in Inclusive Education Settings: The Mediating Effects on Prior-achievement Gaps

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**Abstract**

Increasing emphasis is laid on non-cognitive academic skills such as persistence for explaining and improving learners' success and progress in learning and achievements. Research shows that poor task-persistence in accountable for poor students' achievements. This study investigated the effect of differentiated instruction on students' task-persistence in inclusive Education setting. The study further sought to find out the moderating effects of prior-achievement on mathematics task-persistence of students taught with differentiated instruction compared to those in control condition. The study adopted a pretest-posttest control group quasi-experimental research design involving one experimental group and one control group. A total of 158 Senior Secondary II students and 4 mathematics teachers, from 4 intact inclusive classes participated in the study. Three instruments; Academic Task-persistence Scale (ATPS); Open-ended mathematics task (OEMT) and Prior - Achievement Record Sheet (SPMAS) were used for data collection. Data were analyzed using descriptive statistics and Repeated measures Analysis of Variance (ANOVA). Findings revealed that differentiated instruction significantly improved academic task-persistence of students compared to control condition. Prior-achievement had significant influence on the students' persistence in mathematic task, which was mediated by DI. It was concluded in the study that differentiated instruction encourages active participation of students and enhances their task-persistence.

**Key words:** Differentiated Instruction, Task-persistence, Inclusive Education, Prior-achievement

## Introduction

Mathematics is an interdisciplinary subject which applies to all areas of education, learning and endeavours (Richard & Robbins, 2013). Mathematics is applied in science, technology, human resource and career developments (Salan, 2005; Gravemeijer, Stephan, Julie, Lin, & Ohtani, 2017) and so is a basis for worldwide development. Developing math skills is increasingly fundamental given that mathematics is implicated in 21st century skills, including critical thinking, problem solving and analytical sciences (Gravemeijer, et al., 2017; Partnership for 21st century Skills, 5015; Wagner, 2014), which are gradually forming the basis for employability and career successes. Frey & Osborne (2013) predicted that about 47% of US workforce may lose their jobs in the near future to analysts, critical thinkers and maths-based personnel. In Nigeria, mathematics has been referred to as a tool for re-branding Nigeria (Ezugwu, 2013).

Accordingly, mathematics is not only compulsory in the basic and secondary schools in Nigeria; it is also a prerequisite for entry into tertiary institutions (FRN, 2004; Joint Admission and Matriculation Board Brochure, 2010-2013). These make effective teaching-learning and research in mathematics imperative. Regrettably, poor achievements have been recorded of mathematics at all level of education across the world (Ali, & Jameel, 2016; Arends, Winnaar, & Mosimege, 2017; Izyan Ruzanna, Nor & Zarehan 2017). The delineating poor maths achievement is more evident in Nigeria (Sa'ad, Adamu, & Sadiq, 2014). Among factors attributable for the poor mathematics achievement are those related to the learners, including their lack of persistence in learning mathematics (Onyishi, 2017; Farrington, et al., 2012).

Contemporary educational researches are beginning to de-emphasize abilities or intelligence quotients (IQs) in explaining learners' academic achievements such as grades and scores. Extant evidences are increasingly prioritizing non-cognitive academic skills for students' success and progress in learning (Farrington, et al., 2012; Yeager, & Dweck, 2012). It is increasingly evinced that, non-cognitive skills such as task-persistence, are of significance to learners' growth in intelligence and success; and better predict achievement than IQ (Anderson, 2011; Yeager & Dweck, 2012, Dweck, Walton, & Cohen, 2014). Task-persistence is ability to keep on with an assignment to solve a problem or attain a goal in spite of disturbances, uneasiness or lack of immediate success (Blackley, 2012).

Task-persistence is an academic skill that is of import to learners at all levels and in all domains of academic field. Woolfolk (2011) asserts that task-persistence is a feature of task-involved learners who are not discouraged by the present success or failure but focus on mastery of the task or content such that despite the difficulties they encounter on the task they are able to keep their attention on the tasks. Persistence is particularly critical to subjects like mathematics given the perceived difficulty of their tasks (Sullivan, Aulert, Lehmann, Hislop, Shepherd, & Stubbs, 2013). Furthermore, the procedural nature of mathematics also necessitates persistence because, when students fail to persist on task, it will be difficult for them to become good learners of mathematics. Thus, difference in persistence could account to a great extent, for the consistent poor achievement in mathematics in Nigeria (Onyishi, 2017). Erling, Henry & Robert, (2002) argued that task-persistence is one of the factors responsible for cross national difference in average students' achievement in science and mathematics. Dweck et al. (2014) showed that tenacity, which is synonymous to persistence, promotes long-term learning. Edwards and Beattie, (2016) opined that productive persistence is pivotal for mathematics sense-making. Hence, students' underachievement in mathematics could be partly due to their lack of task-persistence to maintain their learning activities until they achieve the learning goals.

Evidence-based studies have highlighted the importance of helping the learners develop task-persistence in learning (DiCerbo, 2016; Dumdumaya, & Rodrigo, 2018; Roche, Clarke, Sullivan, & Cheeseman, 2013; 2014) mathematics (Abazio, 2018). One of the ways teachers can build students' persistence is through indirect approach of manipulation classroom contexts (Farrington, et al., 2012). However, the inclusive nature of learning contexts since the legislation of inclusive Education in Nigeria (National Policy on Edication, 2004; 2013; UNESCO, 2001) poses more difficulties for regular teachers on how to carry all the students along (Ajuwon, 2008) and help them persist considerably to maximize learning experiences. This is because; in inclusive classrooms the students' come into the classrooms with varying abilities, interests, prior-knowledge, and learning styles (Tomlinson, 2014). Attending to individual needs of the students becomes so challenging to the teacher, who often chooses to "teach to the middle" (Tomlison, 2000). Teaching to the middle complicates learning problems of a greater percentage of the class members since most of the students are either under challenged or over-challenged (Finegan, 2017).

Hence, learners often fail to persist on tasks because a good number of them are left behind in the teaching-learning process (Onyishi, 2017; Tomlison, 2010). This becomes more critical when considering the fact that each student in heterogeneous learning milieu have internal/psychological records of their prior successes or failures in mathematics. Evidences suggest that level of prior-achievement (high, average and low) can have lasting influences on the learners (Çakır, 2014; Tosun, 2009) and could, to a high extent explain how students participate in a given subject (Mbam, 2012). For the teacher to sustain students' persistence in mathematics tasks in such mixed ability (inclusive) classroom, there is need to adopt teaching methods that attend to the students learning needs and sustain learners' interest and motivation to persist (Onyishi, 2017;Tomlison, 2010). To meet up with these challenges posed by the inclusiveness of the present day classroom, instructions need to be differentiated (Tomlinson, 1999).

Instructions can be differentiated through the content, process, product and learning environments, based on the learners' readiness, interests and learning styles (Tomlinson, 2001; Wiselby, 2014). To differentiate through content, the teacher is expected to consider the level of knowledge the students have on the particular topic to be taught and attend to the learners accordingly. For instance, at the point of introducing a topic, some students in a classroom may be completely unfamiliar with the concept; some others may have partial mastery of the content or display mistaken ideas about the content while others may show mastery of the content. Differentiation here involves the teacher designing activities for each group of students in hierarchy of complexities so that all the students can gain and equally be challenged by the learning experience (Anderson 2007; Nunley, 2006).

To differentiate by process, the teacher offers the students different avenues for approaching the learning content based on individual students' learning styles, taking into account the curriculum standard. Based on this, the teacher considers which method is easiest for the students to gain access to the knowledge and what may challenge them most. For instance, some students may prefer to read about the topic while others may prefer to listen while others may need practice in listening; some may acquire knowledge by manipulating objects associated with the content (Nunley, 2006). Thus students who are visual, auditory or tactile learners should be given the opportunity to approach learning according to their preferences.

Differentiating by product involves the teacher offering the students various ways to demonstrate what they have learnt from the lesson unit (Anderson, 2007). According to Anderson, tests, projects, assignments and all kinds of evaluations can be given provided they fall under the student's level of educational standard in respect of the topic being learnt. Thus, the teacher may assign students to complete different activities that demonstrate mastery of the "educational concept" learnt in the lesson unit and allow the students to make choice of the assignment to complete according to their preferences (Tomlinson, 2000; 2001; 2010). In this case, the teacher provides different options for the students to demonstrate mastery of the content, such as writing a report, composing original song with the content or building a 3-dimentional object that explains the mastery of the content in the lesson unit. All these can be put in place using menu unit sheets, choice board or open ended lists of final product options (Nunley, 2006).

Differentiating by learning environment involves the teacher considering the learners' specific characteristics and learning styles in physical classroom arrangements. Some students are visual learners-those who learn best by their sense of sight; some are auditory learners- those who learn best using their sense of hearing while others are manipulative learners- those who learn best by manipulating physical objects. On the other hand, some students may prefer to learn in collaboration with peers, some may prefer to work in small or large groups while others may prefer to work in isolated situations (Brown, 2004)). Based on that, the teacher provides varieties of sitting arrangements and learning materials for the students to learn according to their different styles.

In practical steps, Good and Brophy (2008) presented a model that supports teachers with step-by-step instructional plan using DI. A curriculum-appropriate topic is basic for all teaching methods. According to Good and Brophy, DI of a topic involves the following steps: first, the teacher collaborates with the students to write out the major concepts in the topic; the teacher conducts a pre-assessment on the students to determine their level of readiness, interest and learning styles. This can be through oral questions on the test of entry behaviour or a written test of about five short answer questions which helps both the students and the teacher to identify the readiness level of each student; the result of the pre-assessment is used to group the students according to the level of guidance and scaffolding they need. In grouping, learning styles and preferences are also considered. For this purpose, learning centers and choice boards are drawn for the students to make their choices. After grouping, the teacher anchors learning experiences for the whole group by holding a whole group instruction. This is not an elaborate instruction but a calibrated one; then the teacher provides each group with appropriate learning experience which they engage in based on their needs and prior knowledge; the teacher anchors learning experiences for the whole groups using works from those groups that exemplify an understanding of the topic. Finally assessment is conducted based on the same major concepts.

DI is embedded in such principles as principle of flexible grouping; problem solving; choice; ongoing formative assessment; and recognition of the learners (Robb 2010). Flexible grouping implies that students collaborate in pairs and small groups whose membership changes as needed (Rytivaara, 2011; Brulles, & Brown, 2018). Learning in groups enables students to engage in meaningful discussions and to observe and learn from one another (Biggs, 1999). Through flexible grouping, teachers using DI match tasks, activities, and assessments with the students' interests, abilities, and learning preferences. This helps the teacher to provide each group with learning tasks that are appropriate for them according to their zone of proximal development. Principle of Problem - Solving demands that learning experiences are based on issues, concepts and task-engagement rather than “the book” or the chapter. This encourages all students to explore big ideas and expand their understanding of key concepts through problem solving. In respect of this, the teacher’s responsibility is to present the learning tasks in a logical manner based on the different group characteristics and allow each group to engage in their respective tasks (Woolfolk, 2011; Robb, 2010)

In recognition of diverse learners, the teacher considers the fact that students have diverse levels of expertise and experience with reading, writing, and thinking, problem-solving, and speaking (Voltz, Sims, & Nelson, 2010). Determine student interest by using interest inventories and including students in the planning process. Teachers can ask students to tell them what specific interests they have in a particular topic, and then try to incorporate these interests into their lessons. Identify student learning styles and environmental preferences (Tomlinson, 1999; 2000; 2014). Another critical decision is that of varying learning activities. It is an important way to provide appropriate opportunities for all students to explore concepts. This may involve adapting how students participate; providing adapted equipments or materials; or varying the degree of structure or open-endedness of the tasks; Collaborative learning activities; tiered assignments; changing the pace of delivery of instruction, and using visual and verbal cueing are examples of how learners’ needs can be captured (Tomlinson, 1999; 2000; 2014).

Therefore, to put these principles into practice, planning for DI involves making informed decisions about the learning environment, instructional time, content, materials and resources, instructional strategies and evaluation procedures taking into cognizance that a proactive, flexible and student-centred approach is the key to providing instruction that maximizes opportunities for all students to learn.

Research studies consistently show the efficacy of DI in improving students' achievement across learning contents. For instance, Koeze, (2007) conducted a study on effect of DI on student achievement in an elementary school elementary school and found that differentiation strategies of choice and interest play a vital role in achievement and student satisfaction. Garba, (2015) investigated the effectiveness of DI on students' geometric achievement of senior secondary schools in Kebbi state, Nigeria. Results showed positive effect of DI on achievement. Scardino (2011) also recorded DI as efficacious in improving understanding of middle school science concepts in Hong Kong, China. Abdullah, Roslan, Abdullah and HajiMaming (2014) found improved students' achievement in writing skills in Arabic as a foreign language in Malaysia with DI. Other empirical works attesting to the effectiveness of DI in improving achievements include (Kadum-Bošnjak, & Buršić-Križanac, 2012; Gilbert, 2011; Njagi, 2015; Karadag, & Yasar, 2010; Ogunkunle, & Henrietta, 2014).

Nevertheless, no study to the best of the researchers's knowledge has explored the effect of DI on task-persistence in mathematics in inclusive schools in Nigeria, where poor achievement in mathematics has become a National problem. The present study sought to fill this gap by adopting DI in a class-wide teaching and learning of mathematics to find out if students' mathematics task-persistence would improve. Therefore, the research questions are: will there be improvement in students' mathematics task-persistence (MTP) after a whole term DI in mathematics?; To what extent would improved MTP of students be sustained across follow-up?. Will DI mediate the effects of poor prior achievement on students' persistence in mathematics after intervention?.

# Method

***Ethical consideration***

The teachers in the study gave written consent declaring their interest in participating in the study. Students were assured of unanimous analysis and presentation of their data. Identifying students' level of prior achievement was by giving them Id number based on their serial number in the school record. Students were not labelled based on their achievement level. Teachers in the control group were given DI training after the main study.

***Participants***

Participants of the study include 158 (67 male and 91female) senior secondary II (SSII) students and 4 SSII teachers/instructors (3-males; 1 female) drawn from 4 secondary schools in Nsukka Education- zone, Enugu state, Nigeria. To sample the schools used for this study, we conducted a pre-survey of all the 3,321 SSII students in all the 19 mixed secondary schools in the area, using students' mathematics task-persistence scale (MTPS). We subjected the collected data to descriptive statistics in order to find out the schools whose students demonstrated the lowest level of persistence. 73.68 % (15 schools) of the schools in the area had low mean scores, showing a generally low mathematics task-persistence among students in the area. However, four schools were randomly selected from the 15 at-risk schools and used for the study. The 4 schools selected were randomly assigned to experimental and control conditions. The instructors who implemented DI in the schools were regular teachers who were all with Bachelor of Science Education (BSc.Ed) in Mathematics

Education. All the teachers have a minimum if 7years of experience as maths teachers. Table 1 shows students' demographic variables. 67 (42.41%) of the students were males while 91 (57%) were females. 48 (30.38) were high-achievers in maths; 86 (54.43%) were average maths performers while 24 (15.19%) were low performers.

***Table 1: Students' demographic variables***

| Variable | Category | Exp 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 (50.63) | 78 (49.36) | 158 (100) |
| Prior-achievement | High | 21 (13.29) | 27 (17.08) | 48 (30.38) |
| | Average | 45 (28.30) | 41 (25.94) | 86 (54.43) |
| | Low | 14 (3.16) | 10 (1.89) | 24 (15.19) |
| | Total | 80 (50.63) | 78 (49.36) | 158 (100) |

**Exp=Experimental group; n= number**

***Instruments for Data Collection***

Students' Mathematics Task-persistence Scale was used to collect self-reported data while Open-ended Mathematics Tasks (OEMT) helped us to gather data about students' behavioural task-performance. Students' Prior Mathematics Achievement Record Sheet (SPMARS) was used to collect information about students prior-achievement in mathematics.

**Students' Mathematics Task-Persistence Scale (SMTPS)**: this is a four point rating scale ranging from Strongly Agreed (SA), Agreed (A), Disagree (D) to Strongly Disagree (SD). It is made up of 25 items which were adapted from the standardized Persistence Scale for Children (Lufi & Cohen, 1987) and Self-Reported Persistence Items developed by Bulent (2010). Lufi and Cohen's scale is made up of 40 items addressing children's general persistence, with reliability coefficient value of 0.82. In the instrument, the children are expected to answer yes or no. The researchers selected 19 items from the scale reframed them to measure persistence in mathematics. The scale was also restructured into a four point rating scale instead of yes or no questions. Further, Bulent (2010) is a 7-point rating scale ranging from 1 (not at all true for me) to 7 (very true for me). The original version of this instrument is made up of eight items with reliability coefficient value of 0.77. The researchers adapted 7 out of the 8 items of the instrument. SMTPS is made up of both positively worded and negatively worded items. Positively worded items were scored in order of: SA = 4 points, A = 3points, D = 2points and SD = 1 point. On the other hand, negatively worded items were scored in the order of: SA = 1point, A = 2 points, D = 3points, and SD = 4 points. Three of experts in Educational Psychology and Measurement and Evaluation determined the face validity of the instrument. Crombach Alpha statistic was used to determine the internal consistency of the instrument and yielded reliability coefficient value of .73.

**Open–Ended Mathematics Tasks (OEMT):** Due to limitations of self-report measure of persistence (Breen, Cleary, & O'Shea, 2010). OEMT was developed to measure the behavioural aspect of students' persistence in solving mathematics tasks on the form of Time-on-Task (ToT). The instrument is made up of 4 questions in the other of difficulty. The first three tasks were simple arithmetic tasks which all the students could answer correctly in about 2-3 minutes each. The 4$^{th}$ task was an open-ended question that was impossible to arrive at a correct answer question. The main item of the instrument to measure persistence was item number 4. The earlier items were strategically meant to allow the students experience some level of success for psychological balance. The item 4 question was adapted from Wu (1994), and it reads: i*) using a sheet of construction paper, build the biggest box possible, i.e., the box with the biggest volume. By a box, we mean a container with four* *rectangular sides and a rectangular bottom. Your box should have a top. ii) Describe the box you think is the biggest. Try to come up with an intuitive explanation of why that box is bigger than any other box. iii) Using a second sheet of construction paper, make the biggest box possible without a top.* This instrument was face validated by three experts in mathematics Education and was trial tested on 10 SSII students outside the study area. The trial testing supported the usability of the instrument for the study sample. No time limit was given to students rather, they were instructed to submit as soon as they finished, or cannot continue. Persistence was measured based on time students spent on task.

**Students' Prior Mathematics Achievement Record Sheet (SPMARS)** is an instrument designed to collect data on the students' prior-achievement from the school records (Progress register). This instrument is a proforma with six columns: first column is meant to record the serial number, second column is name of students; third, fourth fifth and sixth columns are for first term, second term, third term and average scores respectively as it is in the previous school session. The researchers copied these data and then the serial numbers on the sheet were given to the students as identification number before the commencement of testing and experiment. The students were also required to write their identification numbers on top of their instruments during each testing. I used information collected with SPMARS to group all students' tests into three - Low, Average and High-achievers. The bench marks include: low (mean score= 0-49); Average (mean=50-65); and High (mean=above 65).

**Procedure**

***Differentiated instruction training program***

We (The researcherss and the research assistant) conducted a 5 days training workshop with follow up for the two math teachers in the Experimental group. This held 2 week before resumption of first term, 2017/2018 academic session. Teachers in control group were not involved in DI training workshop.

To guide the training, we developed a training package which was used for 3 hours training each day for five days. The training was aimed at educating the teachers on the concept of DI; classroom implications of the teaching strategy:  and activities of the teacher during DI. The training sessions were guided by DI manual developed by the researchers (Onyishi, 2017) to facilitate easy access to the workshop information. Sessions activities included:

**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 learnt) and environment (classroom condition). Explicit discussion was made on specific practices associated with each element. Bases for DI were also discussed, including readiness, interest, and learning styles.

**Day3:** DI strategies were discussed, such as jigsaw, goal setting, ongoing and formative assessment, compacting, respectful tasks, flexible grouping, tiered assignment, learning contracts, teaching-up, etc. All these were discussed in details in the training manual. We also held interactive session with the teachers on the concepts discussed how personally they could bring these to bear in their mathematics class. All these including questions for discussion are contained in DI manual.

**Day 4:** Collaboration with the teachers. Through collaboration discussed selection of learner-oriented teaching materials. We drew from the topics that were to be covered to explicate materials and method in each case. Assignment was given to the participants to develop a framework for DI in two of the topics to be covered during the term. These included three broad topics which include: Geometry and trigonometry 1&2 (Chord properties and circle theorems); Algebraic Processes 1 (Quadratic equation); and Number Numeration 2 (Approximations) as it is contained in the curriculum, using New General Mathematics (A standard mathematics text widely used in the area).

**Day 5:** Discussion continued Collaboration to develop a comprehensive framework of DI continued. Revision and question sessions were held and finally we fixed a follow up day. On the follow up day, we collated Ideas, compared the developed whole term DI plans on the topics listed above in day 4. We checked coverage of the curriculum objectives of each topic and the extent to which the lesson plans are differentiated: for instance, we ensure that the plan takes care of students differences by i) following different formats; ii) varying students tasks in complexity and perspectives iii) plan for on-going assessment; provision of learning material iv) provision for flexible grouping

**Follow up:** At follow-up exercise, we held interaction sessions to validate the teachers' preparation to implement the DI. Financial reinforcement was offered to the teachers. We also discussed the flexibility of DI. Each teacher exemplified the skills learnt from the DI training workshop.

**Design and Data Analysis**

A pre-test-post-test quasi-experimental research design was adopted in the study. Quantitative data were collected using self-report measure and Time-on-Task schedule. Quantitative data collected were analyzed using mean, standard deviation, Repeated Measures ANOVA and ANCOVA.

**Table 2:** ***Repeated Measure ANOVA on the Effect of DI on Pre, Post and Follow-up of Students' Mathematics Task-Persistence (MTP) Scores***

| Measure (SMTPS) | DI Group (n = 80) $\overline{X}$ , **SD** | Control Group (n = 78) $\overline{X}$ , **SD** | Df | F | P | 95%CI | $\eta^2$ |
|---|---|---|---|---|---|---|---|
| Pre-test | 41.02±12.74 | 43.22±10.76 | 1, 151 | 6.915 | .301 | 35.84, 48.15 | .004 |
| Post-test | 72.53±7.57 | 36.16±11.25 | 1, 151 | 77.19 | .000 | 68.097, 77.783 | .338 |
| Follow-up | 85.96±8.17 | 37.67±11.73 | 1, 151 | 105.28 | .000 | 66.940, 77.323 | .411 |

**Results from self-report measure (SMTPS)**

Table 2 shows the mean MTP scores and standard deviations of students DI group and those in control group. At baseline (pre-test data), mean MTP score of the DI group (41.02±12.74) and the (43.22±10.76) did not vary significantly $F$ (1, 151) = 6.915, $p$ = .301, $\eta^2$ = 004. This indicates that the two groups had low persistence before DI intervention. The results revealed significant main effects of DI (treatment) on MTP of students $F$ (1, 151) = 77.19, $p$ =.000, $\eta^2$ = .338, compared to the control group. At follow-up evaluation, the DI group (85.96±8.17) had higher rating of their MTP than the C group (37.67±11.73) which was significant ($F$ (1, 151) = 105.28, $p$ =.000, $\eta^2$ = .411). This shows that the positive effect of DI on students' MTP was sustained. These imply that DI led to sustained improvement in MTP among the participants. Therefore the hypothesis of significant improvement in mean MTP of students after a whole Term DI maths learning was accepted.

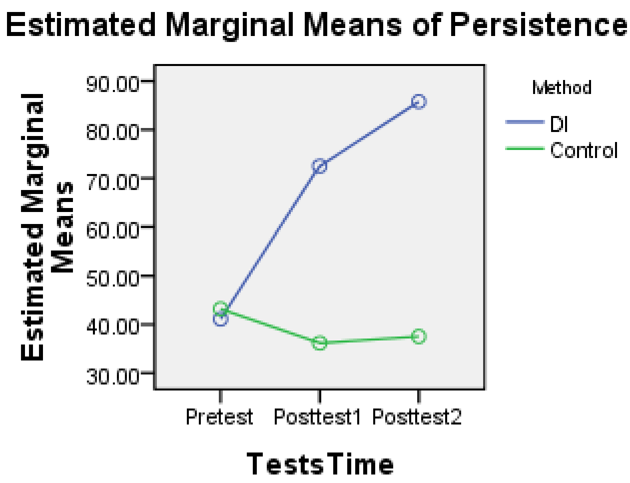


**Figure 1: Graph of the Interaction effect of teaching method and test time on MTP of participants**

To further find out the changes in task persistence across test time (baseline data, posttest and follow-up), a 2 x 3 Analysis of Covariance for the interaction effects of treatment and test time was conducted. Result revealed a significant interaction effect of methods x time on mathematics task-persistence, ($F$ (2, 151) = 4.581E4, $p$ = .000) of participants. The result is graphically represented in Figure 1. The mean task-persistence rating of the DI group increased significantly from pretest to posttest, and from posttest to follow-up (post-test 2), while that of the control group did not have significant change across the test times.

Analyzing data by prior-achievement (Table 3), baseline data (Pre-test) revealed no significant differences in the MTP scores of the high (mean difference=0.1; F=77.189; p=.431), average achievers (mean difference=.52; F=48.282; p=.166) and low-achieving students (mean difference=-.82; F=6.915; p=.063) of DI and control groups.

**Table 3: Repeated Measure Analysis of Variance on the Effect of DI on *Post-test and Follow-up MTP Scores based on Prior achievement***

| Measures | Prior-Ach | DI $\overline{X}$ , **SD (n=80)** | Control Group (n = 78) $\overline{X}$ , **SD** | Mean difference | Df | F | P |
|---|---|---|---|---|---|---|---|
| Pretest | High (n=48) | 46.99±12.74 | 46.89±10.76 | 0.1 | 2, 151 | 77.189 | .431 |
| | Average (n=86) | 41.04±5.66 | 40.52±10.55 | .52 | 2, 151 | 48.282 | .166 |
| | Low (n=24) | 31.95±7.31 | 32.78±9.45 | -.82 | 2, 151 | 6.915 | .063 |
| Posttest | High (n=48) | 75.94±13.57 | 41.21±11.25 | 34.74 | 2, 151 | 11.335 | .000 |
| | Average (n=86) | 72.35±12.97 | 32.91±8.90 | 39.45 | 2, 151 | 17.599b | .000 |
| | Low (n=24) | 62.88±8.91 | 35.53±7.59 | 27.37 | 2, 151 | 11.109a | .000 |
| Follow-up | High (n=48) | 89.26±8.17 | 44.91±11.73 | 44.34 | 2, | 10.881 | .000 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | 151 | | |
| | Average (n=86) | 83.14±15.02 | 37.54±8.23 | 45.61 | 2, 151 | 20.539 | .000 |
| | Low (n=24) | 72.13±13.01 | 35.47±11.25 | 36.66 | 2, 151 | 10.717 | .000 |

Interestingly all performance groups (high, average and low achieving participants) in DI had higher MTP rating scores than their counterparts in the control groups after intervention (at post-test). High achieving students in the DI group had mean difference=34.74; F=11.335; p=.000; average achievers had mean difference=27.37; F=17.59; p=.000; and low-achieving students had mean difference=-.82; F=11.109; p=.000 over their control group counterparts. These significant differences were all sustained through the follow up assessment. At follow-up test, high achieving students in the DI group had mean difference=44.34; F=10.881; p=.000); average achievers had mean difference=45.61; F=20.539.; p=.000 and low-achieving students had mean difference=36.66; F=10.717; p=.000 over their control group counterparts. These support the hypothesis that DI instruction brings about sustained increase in mathematics task-persistence of students irrespective of their prior-achievements.

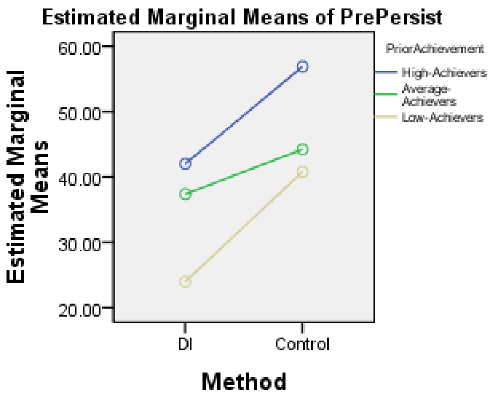


**Figure 2a: Graph of the Interaction effect of treatment and Prior-Achievements on MTP scores of participants**

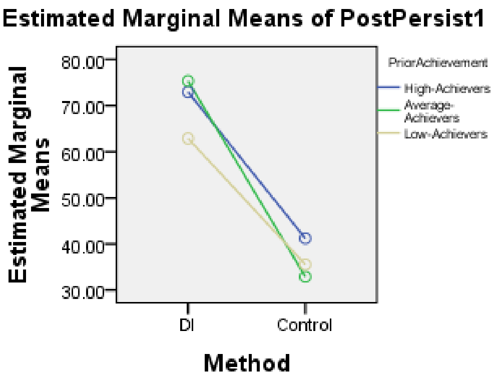


**Figure 2b: Graph of the Interaction effect of treatment and Prior-Achievements on MTP scores of participants at post-test 1**

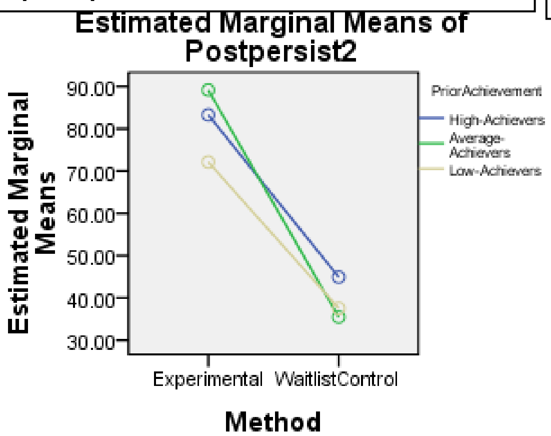


**Figure 2c: Graph of the Interaction effect of treatment and Prior-Achievements on MTP scores of participants at follow-up test**

Figures 2a, b and c further showed the interaction effect of teaching mathods and prior-achievements on mathematics task-persistence of students. The estimated marginal mean plots show that before DI intervention (figure 2a), the MTP scores of students were hierarchically segregated based on levels of prior-achievement in mathematics, while at post test (Figure 2b) and follow-up (figure 2c), the estimated marginal means of students in the DI group were more clustered, ranging from about 68 to 75 in post-test and from 78-89 in the follow-up. This indicated that DI not only bridge achievement gaps, but also counter the helplessness arising from poor prior achievements which often limit students from persisting on mathematics tasks.

**Results from the Open –Ended Mathematics Tasks (OEMT) as measured by Time on Task (ToT)**

Students' Time-on-task (ToT) on item 4 made up the task-persistence for each student. Based on this, the mean ToT of the DI group and control group in pretest, post-test and follow up assessments were compared (see Table 4).

***Table 4: Repeated Measure ANOVA of the Participants' ToT based on Group***

| Measure (Maths Tasks) | DI Group (n = 80) $\overline{X}$ , **SD** | Control Group (n = 78) $\overline{X}$ , **SD** | Df | F | P | 95%CI | $\eta^2$ |
|---|---|---|---|---|---|---|---|
| Pre-test | 8.21±3.89 | 9.42±4.87 | 1,151 | .470 | .494 | 8.12, 9.48 | .003 |
| Post-test | 23.52±9.31 | 10.34±5.67 | 1,151 | 63.45 | .000 | 15.597, 18.380 | .310 |
| Follow- | 23.72±9.28 | 9.65±4.95 | 1,151 | 77.61 | .000 | 15.347, 18.037 | .355 |

The mean ToT of the DI group (8.21±3.89) and the control group (9.42±4.87) did not vary significantly $F$ (1, 151) = .470, $p$ = .494, $\eta^2$ = 003 at baseline (Pretest). This indicates that before intervention, students in the two groups demonstrated equally low ToT (8-9 minutes) in solving mathematics tasks. DI group spent more ToT (23.52±9.31 minutes) than control group (10.34±5.67 minutes) at posttest, showing a significant main effect of DI, $F$ (1, 151) = 63.45, $p$ =.000, $\eta^2$ = .310, on students' ToT. This effect of DI was sustained through the follow-up evaluation, given that DI (23.72±9.28) and CG (9.65±4.95) significantly out-persisted ($F$ (1, 151) = 77.61 $p$ =.000, $\eta^2$ = .355) the control group at posttest 2. Hence, there was significant sustained improvement in mean ToT of students following a whole Term DI maths learning.

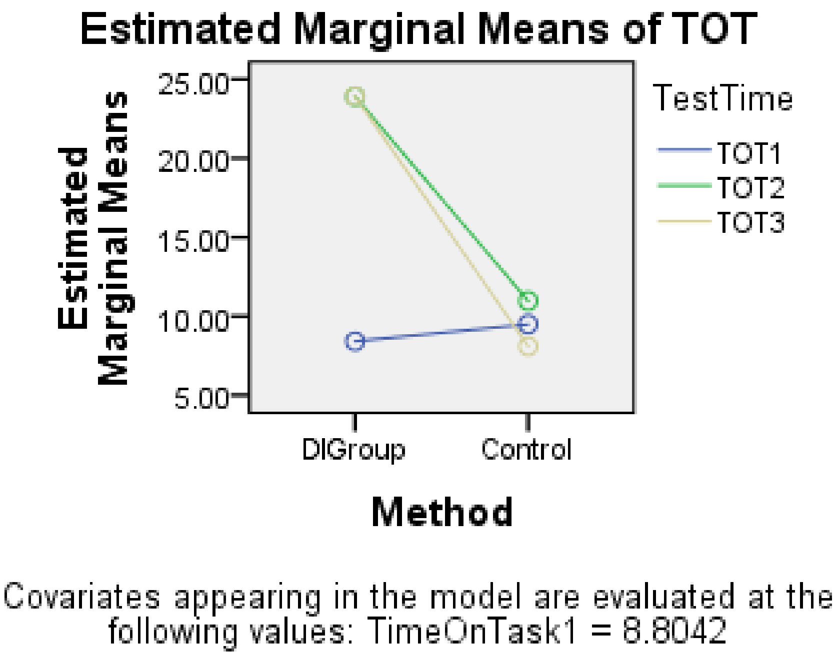


**Figure 3: Graph of the Interaction effect of teaching method and test time on MTP as measured by ToT of participants**

The 2 x 3 analysis of covariance for the interaction effects of treatment and measures (pre, post and follow-up tests) further revealed a significant interaction effect of treatment x time on the time students spend in solving mathematics (ToT), (*F* (2, 151) = 4.581E4, *p* = .000). This result is graphically represented in Figure 3, showing that, while the mean ToT of the DI group increased significantly across pretest , posttest 1 and posttest 2, control group did not have significant change across the test times.

**Table 5: Repeated Measure Analysis of Variance on the Effect of DI on ToT at *Post-test and Follow-up based on Prior achievement***

| Measures | Prior-Ach | DI $\overline{X}$ , SD | Control Group (n = 78) $\overline{X}$ , SD | Mean difference | Df | F | P | 95%CI | $\eta^2$ |
|---|---|---|---|---|---|---|---|---|---|
| Pretest | High (n=) | 12.51±3.74 | 12.38±4.59 | 0.13 | 2, 151 | .470 | .644 | 11.24, 13.44 | .02 |
| | Average (n=) | 7.91±2.63 | 8.00±4.60 | -.10 | 2, 151 | .153 | .118 | 6.74, 9.35 | .02 |
| | Low (n=) | 5.74±2.45 | 7.11±2.26 | -1.37 | 2, 151 | .479 | .414 | 4.91, 8.07 | .03 |
| Posttest | High (n=) | 27.09±7.16 | 12.39±5.09 | 14.72 | 2, 151 | 63.453 | .000 | 17.28, 22.22 | .43 |
| | Average (n=) | 22.36±10.27 | 9.24±6.07 | 13.12 | 2, 151 | 73.599b | .000 | 14.15, 17.46 | .31 |
| | Low (n=) | 22.39±7.32 | 8.22±1.79 | 14.17 | 2, 151 | 65.521 | .000 | 12.14, 18.69 | .35 |
| Follow-up | High (n=) | 27.51±7.16 | 12.02±4.55 | 15.49 | 2, 151 | 61.34 | .000 | 16.88, 21.66 | .39 |
| | Average (n=) | 22.57±10.18 | 8.48±5.22 | 14.09 | 2, 151 | 63.99 | .000 | 14.12, 17.32 | .52 |
| | Low (n=) | 21.71±7.72 | 7.77±.83 | 13.94 | 2, 151 | 63.89 | .000 | 11.92, 18.27 | .67 |

Table 5 shows the ToT (in minutes) and standard deviation of high, average and low-achieving students in DI and CG groups. The baseline data (Pre-test) revealed no significant differences in the time spent on mathematics tasks (ToT) by high (mean difference=.13; F (2,151)=.470; p=.644; $\eta^2$=.02); average achievers (mean difference=-.10; F (2,151)=.153; p=.118; $\eta^2$=.02) and low-achieving students (mean difference=-1.37; F (2,151) =.479; p=.414; $\eta^2$=.03) of DI and control groups. At posttest (ToT2), high, average and low achieving participants in DI spent more time on task than their counterparts in the control group. High achieving students in the DI group had mean difference=14.72; F (2,151) =63.463; p=.000; $\eta^2$=43 over their control group counterparts; average achievers had mean difference=13.12; F (2,151) =73.59; p=.000; η2=.31; and low-achievers had mean difference=14.17; F (2,151) =65.52; p=.000; η2=.35 over their control group counterparts. At follow-up test, high achieving students in the DI group still spent more time (mean difference=15.49; F (2,151)= 61.34; p=.000; $\eta^2$=.39) than their counterparts in the control group; average achievers had mean difference=14.09; F (2,151) =63.99.; p=.000 $\eta^2$=.52 and low-achieving students had mean difference=13.94; F (2,151) =63.89; p=.000; $\eta^2$=.67 over their control group counterparts. These support the hypothesis that DI instruction brings about sustained increase in mathematics task-persistence.

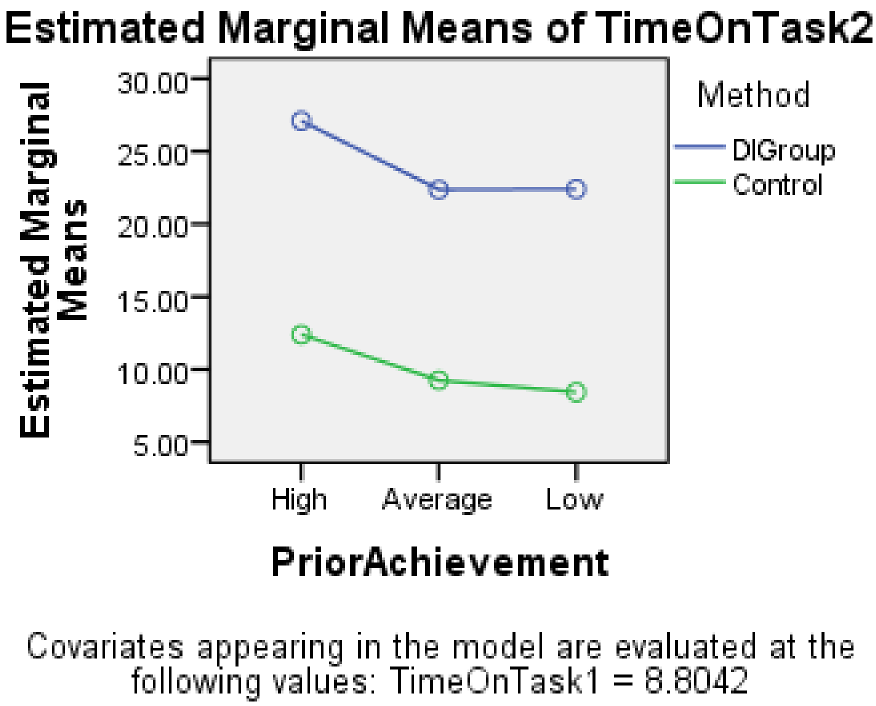


**Figure 4a: Graph of the Interaction effect of teaching method and prior-achievement on MTP of participants as measured by ToT2**

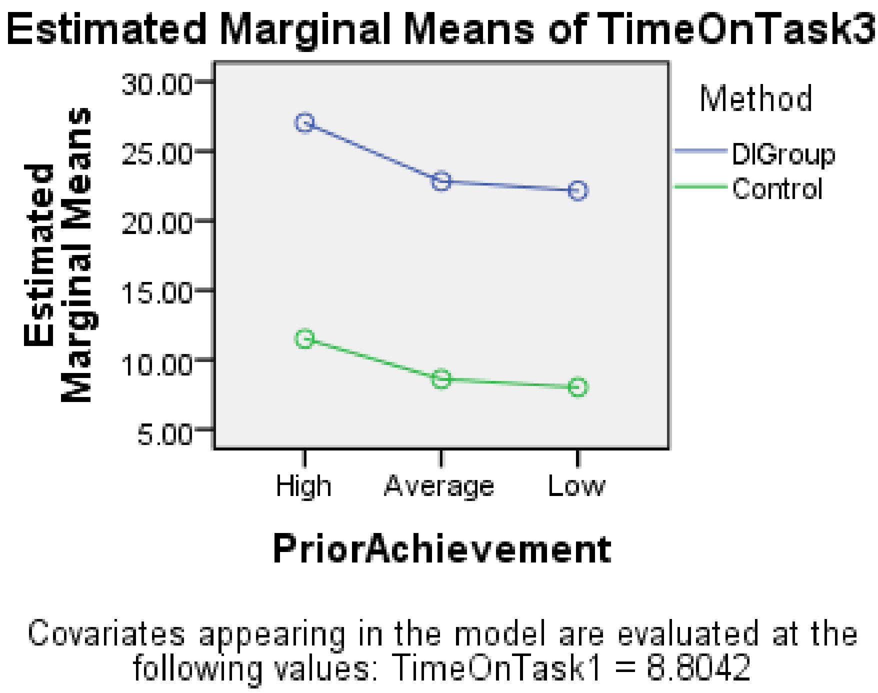


Figure 4b: Graph of the Interaction effect of teaching method and prior-achievement on MTP of participants as measured by ToT3Figures 4a, and b further showed the interaction effect of teaching methods and prior-achievements on students' ToT. The plots (figure 4a and b) show that students' ToT scores at both posttest (ToT2) and follow-up (ToT3) differed significantly based on methods (DI or control), and not based on levels of prior-achievement in mathematics. This indicated that DI bridges prior achievement gaps, in students' mathematics task-persistence as measured by time-on-task.

## Discussion

Findings of this study revealed that DI led to a significant increase in the students' self-reported mathematics task-persistence. Measured by time-on-task, students also persisted more in solving mathematics problem after DI intervention. This agrees with the earlier findings of Hui and Nanyang (2007), that anchoring improved students' task-persistence. Invariably, Eze, 2003 found that providing students with skills in learning strategies that involve self-regulation and increase participation of students is an effective way of enhancing their persistence in tasks. The students' improved mathematics task-persistence could for the fact that DI adopts an activity - centred and learner-centered approach to learning, where students' diverse learning needs are highly considered. In DI diverse learning materials and methods are provided for the students to make choices of those that most appeal to their learning needs. In that way, learners nurse emotional states, motivation, curiosity and interests that improve their persistence on tasks.

Level of task-persistence of students can improve following reinforcement for task completion; difficulty of the task for the learners, expectation of success in the environment, alternatives to the task and task interest (DiCerbo, 2014), which are embedded DI. Eventhough DI has not been extensively researched in the area of persistence, its success so far in improving students' achievements (Abdullah, Roslan, Abdullah and HajiMaming, 2014; Garba, 2015; Kadum-Bošnjak, & Buršić-Križanac, 2012; Gilbert, 2011; Njagi, 2015; Karadag, & Yasar, 2010; Ogunkunle, & Henrietta, 2014) supports the hypothesis of this study, given the link between achievement and persistence (Anderson 2011; Yeager & Dweck, 2012, Dweck, Walton, & Cohen, 2014). When mathematics instruction is differentiated, all the students are given the opportunity to build on their zone of proximal development (Onyishi, 2017; Tomlinson, 2000; 2001; Vygosky, 1978). Anchoring learning on the learners' ZPD tends to make learning more real, concrete, spiral and gives the learners the impetus to build on what they already know. Collaborative learning activities, tiered assignments, changing the pace of delivery of instruction, and using visual and verbal cueing as in DI help sustain students' feeling of wanting to complete tasks (Onyishi, 2017).

Another major finding of this study is that prior-achievement as a factor has a significant influence on mathematics task-persistence of students and those influences did not limit students' participation in DI and or the positive effects of DI. High average and low achieving students in experimental group recorded higher self-report task-persistence rating scores, and higher time-on-task (ToT) than high, average and low achievers in the control group respectively. On a general note, the mean task persistence scores of all the high-achievers were significantly higher than those of the low-achieving students. Analysis of covariance (ANCOVA) for prior-achievement as a main effect indicates that there was a significant difference in the mathematics task-persistence of high, average and low achieving students.

The result is in line with that of Post, Medhanie, Harwell , Dupuis, Muchlinski, Andersen and Monson, (2010) who found that, prior mathematics achievement mediated the relationship between High school curricular and Post secondary school students' persistence in mathematics. If prior-achievement mediates the relationship between the curriculum and task-persistence, it implies that prior achievement significantly influences persistence. For instance, a student who has experience prolonged success in an area tends to believe that he could succeed in tasks relating to that area. Consequently, even if such individual encounters difficulty or delay in overcoming such task he tends to persist, believing to make it with additional efforts. Paul, Lemay and Tenzin, (2016) showed that Prior- academic performance was a significant predictor of college performance, persistence as well as success in the gateway physics course. This implies that prior-achievement significantly influences the students' persistence, such that the higher the prior-achievement the higher the task-persistence in the same field of study. High average and low achievers differ in both their motivational patterns and their academic self-perceptions and sometimes cognitive development (Çakır, 2014). In earlier years, many professionals readily accepted that individual psychological differences (such as persistence) accounted for failure to learn in school. Students' expectations for failure frequently develop as a result of prolonged experiences with instruction that fails to result in successful performance. When instruction is effective (when students master targeted competencies); performance is enhanced and this results in positive perception self in form of competence that sustains the motivation to persist on difficult task.

When DI is adopted in teaching multiple ability classroom, high, average and low-achievers' tend to work individually and, or in groups, based on their readiness (level of expertise) and choices. This helps each student, irrespective of their level of prior-achievement to experience a quantum of success and positive emotions necessary for persistence (Valiente, Swanson, & Eisenberg, 2012). Extant literature suggests that reinforcement for task completion; difficulty of the task to the learners, expectation for success, alternatives to the task and task interest (DiCerbo, 2014) are determinants of students' task-persistence. Expectation of success takes root from the students' past experience of success or failure (Khattab, 2015) and could interact with reinforcement, task-difficulty alternatives and interest which are strictly put in place during DI to keep all students persistent on a given mathematics task. When students are allowed to tackle challenging tasks on their own, the device strategies engage in sustained thinking, decision making, risk-taking and productive struggle (Livy, Muir & Sullivan, 2018; Roche, & Clarke, 2014; Warshauer, 2015; Roche, Clarke, Sullivan, & Cheeseman, 2013), necessary for success.

On the other hand, task-persistence is a feature of task-involved learners with productive habit of mind, who are not discouraged by present difficulty, but focus on mastery of the task or content (Roche, Clarke, Sullivan, & Cheeseman, 2013). Learners with academic tenacity have growth mindset ((Farrington et al., 2012) such that despite the difficulties they encounter on the task they are able to keep their attention on the task. Given that DI helps the teacher to keep all the learners involved in the task, all the learners persist equally building on their individual prior knowledge. Furthermore, getting all the students engaged on task at varying levels (a major feature of DI) tend to redirect the mindsets of the learner, from worries about performance, fear of failure or concerns for looking smart being motivated by the task, and developing a sense of 'I can do it', (Yeager & Dweck, 2012) which sustains efforts and persistence.

## Conclusion

It is established that DI is efficacious in teaching inclusive classroom where individual differences in abilities and achievements typify class members. When low task-persistence in learning mathematics characterises the learners, DI could help to sustain the students' motivation and improve task-persistence. DI intervention works when poor prior-achievements discourage students from persisting on maths tasks.

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