International Journal of Advanced Research, Volume 5, Issue 1, 2022
Article DOI: https://doi.org/10.37284/ijar.5.1.715

International Journal of Advanced Research
ijar.eanso.org
Volume 5, Issue 1, 2022
Print ISSN: 2707-7802 | Online ISSN: 2707-7810
Title DOI: https://doi.org/10.37284/2707-7810

EAST AFRICAN NATURE & SCIENCE ORGANIZATION

Original Article

Individual Differences and Instruction in Mathematics: A Review

Dr. Mbuthia Ngunjiri, PhD[1*]

[1] Laikipia University, P. O. Box 1100-20300 Nyahururu, Kenya
* Author for Correspondence ORCID ID: https://orcid.org/0000-0002-4047-0950; Email: mbuthiangunjiri@gmail.com.

Article DOI: https://doi.org/10.37284/ijar.5.1.715

Publication Date:

20 Jun 2022

Keywords:

Individual Differences, Mathematics Instruction, Mathematics Teacher, Teaching, Learning Process.

ABSTRACT

This paper focuses on some of the individual differences that exists among learners in mathematics which are likely to affect their learning. Since learners are not alike cognitively, a mathematics teacher has a challenge of recognizing and developing the potential of each individual learner. In mathematics classrooms, it is important for teachers to understand variables such as general ability to learn, motivation, attitudes, learning styles, gender among others which are individual differences within and between learners, and strategies are presented on how to cater for them.

APA CITATION

Ngunjiri, M. (2022). Individual Differences and Instruction in Mathematics: A Review. *International Journal of Advanced Research*, *5*(1), 84-88. https://doi.org/10.37284/ijar.5.1.715

CHICAGO CITATION

Ngunjiri, Mbuthia. 2022. "Individual Differences and Instruction in Mathematics: A Review." *International Journal of Advanced Research* 5 (1), 84-88. https://doi.org/10.37284/ijar.5.1.715.

HARVARD CITATION

Ngunjiri, M. (2022) "Individual Differences and Instruction in Mathematics: A Review.", *International Journal of Advanced Research*, 5(1), pp. 84-88. doi: 10.37284/ijar.5.1.715.

IEEE CITATION

M. Ngunjiri, "Individual Differences and Instruction in Mathematics: A Review.", *IJAR*, vol. 5, no. 1, pp. 84-88, Jun. 2022.

MLA CITATION

Ngunjiri, Mbuthia. "Individual Differences and Instruction in Mathematics: A Review.". *International Journal of Advanced Research*, Vol. 5, no. 1, Jun. 2022, pp. 84-88, doi:10.37284/ijar.5.1.715.

INTRODUCTION

Individual differences among students are personal differences specific to each student (Kubat, 2018). There are several types of individual differences which exist among learners in the learning of mathematics which include; general ability to learn, interests, attitudes, motivation to learn, prior knowledge in a topic, preferred learning styles, self- efficacy in specific tasks, self- concept in mathematics, and students' physical characteristics such as gender among others (Ari & Deniz, 2008). The differences that exist among learners can cause them to learn at different rates, to succeed or fail, to be interested or be bored in class (Good & Brophy, 2008).

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REVIEW OF LITERATURE

In a mathematics classroom, individual differences tend to be hidden and so the mathematics teacher can only discover the differences after interacting academically with learners for some time. Therefore, the mathematics teacher needs to spend time to find the nature of each individual learner in order to know something about their weaknesses and strengths so as to help them overcome their obstacles (D'amico & Ve- Gallaway, 2008). According to Celep (2004), the needs of the learners are very important factors that guide the behaviour of the learners in the classroom. Therefore, when teaching activities are planned, the teacher will be able to use methods that meet students' individual differences and needs, and will enable students to develop their skills as well as to ensure that the teaching process is successful. Twoli et al. (2007) argued that there are various methods at the mathematics teachers' disposal which could be used to identify learner's individual differences. Twoli et al. (2007) posit that they include: observation, interviews, use of records, use of tests, use of teacher-students conferences, use of open days, and use of attitude tests.

First, in an observation, the mathematics teacher can observe the learner's behaviour in and outside the classroom in such areas like participation in class activities, physical appearance (e.g., emotional stability), interpersonal relations, and physical challenges (Caratiquit & Pablo, 2021). Second, oral, or written interviews can be used to obtain as much information about the learner in particular subjects. Specifically, in mathematics, interviews can cover areas like interests and attitudes towards the subject. According to Twoli et al. (2007), the interviewing process provides a unique method for determining what children know or perceive, and is an innovative way to understand students in any science course.

Third, there are several records which can be used to provide information about each individual learner. They include: academic progress records in mathematics, and class attendance registers (Twoli et al., 2007). Twoli and colleagues posit that progress records can show information about academic progress of each student, while the attendance register indicates how regularly each student attends mathematics lessons. Absenteeism may be due to lack of interest in learning or peer influence from some un- interested students. Fourth, classroom mathematics tests can be used to identify learner's individual needs. Educational researchers have found out that effective teachers regularly assess what they do in the classroom, and whether their students are really learning through frequent tests and feedbacks (William, 2007). Furthermore, in the course of regular classroom activities, they can collect information about how students learn, what they seem to know and be able to do, and what interests them.

Fifth, mathematics teachers and their students can hold formal conferences where the latter talk freely about their needs (Twoli et al., 2007). Through the conferences, mathematics teachers can gather as much information about learner's problems, and attitudes. Sixth, mathematics teachers can engage parents during school open days. During the open days the teacher can find out information about the learner's background from their parents (Twoli et al., 2007). Lastly, attitude toward mathematics tests can be used to assess students' attitudes towards the subject. According to Mohamed and Waheed (2011), there are three groups of factors that play a vital role in influencing student attitudes. These are; factors associated with the students themselves (e.g., mathematics achievement, anxiety, self- efficacy, self-concept, motivation, and experiences at school), those associated with teaching (e.g., teaching materials, classroom management, teacher knowledge, guidance, and beliefs), and factors from the home environment (e.g., parental expectations and educational background).

There are several methods for catering for individual differences in mathematics classrooms. The methods can either be administrative (i.e., school-based) or teacher-based in the classroom (Twoli et al., 2007). Administrative methods include ability grouping. Twoli et al. (2007) defined ability grouping as organization of learners into groups for instruction based on demonstrated intelligence, and general or specific aptitude. In its most rigid form (known as streaming or tracking) students are segregated for extended period into parallel but separate tracks or streams, leading to different academic and career outcomes. Slavin (1987) posits that ability grouping is the practice of grouping students by potential or past achievement. For example, those who are gifted in the sciences which include mathematics can be put into parallel but separate tracks.

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At the classroom level, it is the teacher who must meet the challenge of providing for individual differences in mathematics lessons. The following are specific examples of classroom provision for individual differences. They include; supervision and guidance during the lesson, giving frequent and selective assignments, organization of class groups, offering individualized instruction, remediation, enrichment, improving level of motivation to learn, ensuring prerequisite knowledge, use of preferred learning styles, and being sensitive to gender differences (Twoli et al., 2007).

First, supervision and guidance during mathematics lessons involve individual contact or interaction with students while they are working on a specific task. Djigic and Stojiljkovic (2011) asserted that both teachers and students are most satisfied with classroom climate which is created by teacher-student interactionism and student achievements were at its highest when the teachers practiced interactionist styles in the classroom.

Second, the mathematics teacher should give frequent and selective assignments (Twoli et al., 2007). Koh and Luke (2009) found a positive relationship between teacher assignments and success in student work in Singapore middle school math classrooms. Through frequent assignments, the mathematics teacher is able to monitor students' weaknesses and strengths (Twoli et al., 2007), and if possible, assignments can be varied to suit individual student needs.

Third, the mathematics teacher can organize frequent within class groups where able students are involved in peer tutoring of other students. According to Bloom (1974), providing opportunities for small groups of students to help each other is the most effective form of assisting slow learners. Furthermore, in class groups, the faster learners are a natural choice as tutoring agents because they have the aptitude and extra time.

Fourth, the mathematics teacher can offer individualized instruction, which consists of planning learning tasks and designing instructional techniques to meet the unique needs of each student. According to Switzer (2004), individualized instruction is a method of instruction in which there is one - to - one teaching and self - paced learning leading to the achievement of course objectives. In their view, the intent of individualizing instruction is to maximize each student's growth and individual success, and assisting in the learning process. It provides the opportunity for students to learn at their own pace, in their own way, and be successful. The most common method of offering individualized instruction is through extra – tuition after school hours, during weekends, and during school holidays (Twoli et al., 2007).

Fifth, remediation is a method that can be used to revise taught content to the underachievers in mathematics. According to Asio and Jimenez (2020), educating learners is the core reason for all teaching – learning processes which are undertaken in each classroom. However, not all students can accommodate the learning processes and this results in different learning outcomes. Lin and Liu (2017) argued that remediation activities have a positive effect on the academic performance of learners. Therefore, students' deficiencies in a topic or topics in mathematics can be done by devoting a lesson or two to remediation with the whole class, usually after the results of a given test.

Sixth, there is a problem of the fast learners in mathematics who tend to complete classroom mathematical tasks very fast. Many teachers attempt to contain gifted learners by providing some kind of enrichment (Stanley, 2021). According to Wiggins et al. (2017), enrichment provides gifted students with the chance to acquire mastery of subject matter at a deeper level than what is specified in the required curriculum. In mathematics, teachers can enrich or add extra – workload to a bright student in a normal classroom, and enrichment can take greater breadth or depth in the same subject or topic.

Seventh, students differ with respect to their motivation to learn mathematics (Gojak, 2013). Gojak argued that some students will be lowly motivated and others highly motivated. Motivated students are persistent on tasks, and they stick with a task, trying various approaches and strategies, asking themselves and others questions until they reach a solution that is acceptable. Hence, the mathematics teacher should try to develop a high level of motivation with every student using the various techniques of motivating learners. According to Ngunjiri (2012), these techniques include; use of stimulus variation in teaching, use of positive verbal and non- verbal reinforcement, use of incentives, use of learning

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hierarchies, providing immediate feedback after tests and examinations, ensuring prerequisite knowledge at the start of every topic, making lesson content relevant and meaningful, creating a friendly classroom atmosphere in classrooms, understanding background of learners, and being a role model through positive behaviours.

Eighth, students differ with respect to the previous knowledge they bring to a mathematical learning task such as a topic or a subtopic (Mayer, 1987). According to Mayer those who possess the relevant prerequisites learn faster than those who lack them. Therefore, the mathematics teacher should ensure that students acquire the necessary prerequisite knowledge before engaging students in a new or a difficult learning task. This can be done by taking review of prerequisites at the start of a new topic or a difficult sub-topic.

Ninth, students differ with respect to the preferred made of processing information known as cognitive style in learning as some will prefer certain teaching methods used by the mathematics teacher than others (Mayer, 1987). In Mayer's view, "it seems premature to advocate the development of separate instructional programs for students with different learning styles" (p. 501). Instead, teachers should be sensitive to the idea that, for a given instructional domain, not all students learn in same way. Mayer posits that "one solution to this problem is to provide small scale individualization of instructional method to fit each student's cognitive style within specific situation, especially when conventional methods do not succeed" (p. 501). In short, the problem of learning style differences can be overcome by using several methods of teaching a mathematics lesson to cater for individual student preferences.

Lastly, there are founded or unfounded claims between boys and girls in an instructional situation, especially in mathematics. Some of the documented claims are,

- Boys have a greater mathematical ability than girls
- Boys are more aggressive than girls
- Girls are more suggestive and have more verbal ability than boys (Mayer, 1987).

However, to overcome any gender differences in the mathematics classroom, the teacher must be gender sensitive and try to reduce any observed differences. For example, the teacher should not let mathematics to be seen as a male domain. Both boys and girls should be told that all can succeed by putting sufficient effort. It is also important for the mathematics teacher to assist the individual learner to develop a self-attribution (i.e., explanation) of effort in learning (Driscoll, 2005; Stipek, 1998).

CONCLUSION

In conclusion, there are major dimensions upon which learners differ. In this paper several categories of individual differences were explored. They include; student general ability to learn, lack of prerequisites, attitudes, motivation to learn, and physical characteristics such as gender. Techniques of identifying learner's individual differences are discussed. They include; observation, interviews, use of records, use of tests, use of conferences, use of open days and use of attitude tests. Lastly, administrative, and teacher-based methods of catering for the individual differences are presented. They include; ability grouping, supervision, and guidance during mathematics lessons, giving frequent and selective assignments, organizing frequent within class groups, remediation, enrichment, developing a good level of motivation to learn, ensuring prior knowledge to every topic, use of preferred learning styles and being sensitive to gender differences. There are of course many other dimensions on which students differ, including emotional stability, anxiety, and interest. However, the ten strategies described in this paper for catering for differences present a representative sample on how to overcome individual differences in mathematics learning.

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