*Journal of Education and e-Learning Research*
*Vol. 9, No. 4, 269-277, 2022*
*ISSN(E) 2410-9991 / ISSN(P) 2518-0169*
*DOI: 10.20448/jeelr.v9i4.4253*


# Impact of Differentiated Instruction on the Mathematical Thinking Processes of Gifted and Talented Students

**Mohd Hasrul Kamarulzaman**[1]
**Mohd Fadzil Kamarudin**[2]
**Mohd Saifun Aznin Mohd Sharif**[3]
**Muhammad Zaim Esrati**[4]
**Mior Muhamad Saiful Nizan Saali**[5]
**Rorlinda Yusof**[6]


*(✉ Corresponding Author)*

[1]*Pusat Bahasa, University Pertahanan Nasional Malaysia, Kem, Sungai Besi, 57000 Kuala Lumpur, Malaysia.*
[1]*Email: hasrul@upnm.edu.my*
[2,3,4,5,6]*Pusat GENIUS@Pintar Negara, University Kebangsaan Malaysia, 43600 UKM Bangi, Malaysia.*
[2]*Email: fadzil_kamarudin@ukm.edu.my*
[3]*Email: saifun@ukm.edu.my*
[4]*Email: zaem@ukm.edu.my*
[5]*Email: mior87@ukm.edu.my*
[6]*Email: rorlinda@ukm.edu.my*

## Abstract

The aim of this study is to examine if differentiated instruction benefits the mathematical thinking process of gifted and talented students in Malaysia. Differentiated instruction is a student-centered technique in which instructors act as facilitators. It is doubtful, however, if differentiated instruction has a beneficial effect on the overall process of mathematical thinking. A disciplined approach to learning mathematics is deemed essential. In this study, a questionnaire was designed to assess students' motivation towards learning using differentiated instruction in mathematics, and a mathematics test was devised to assess students' mathematical thinking process. The study included 400 students who were identified as gifted and talented students; the data were analyzed using the SPSS software. The results suggest that statistically differentiated instruction has a significant effect on gifted and talented students' mathematical thinking processes. However, additional research is needed to discover which activities directly impact students' mathematical thinking processes positively and which should be avoided.

**Keywords:** Differentiated instruction, Mathematical thinking, Gifted student, Learning profile, Learning activities.

**Citation** | Mohd Hasrul, K., Mohd Fadzil, K., Mohd Saifun, A. M. S., Muhammad Zaim, E., Mior Muhamad, S. N. S., & Rorlinda, Y. (2022). Impact of differentiated instruction on the mathematical thinking processes of gifted and talented students. *Journal of Education and e-Learning Research*, 9(4), 269-277. 10.20448/jeelr.v9i4.4253
**History:**
Received: 8 August 2022
Revised: 30 September 2022
Accepted: 12 October 2022
Published: 28 October 2022

**Publisher:** Asian Online Journal Publishing Group

**Funding:** This research is supported by Dana Penyelidikan Pusat GENIUS@Pintar Negara (Grant number: GENIUSPINTAR-2020-002).
**Authors' Contributions:** All authors contributed equally to the conception and design of the study.
**Competing Interests:** The authors declare that they have no conflict of interest.
**Transparency:** The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained.
**Ethical:** This study followed all ethical practices during writing.

## Contents

**Contribution of this paper to the literature**

This study contributes to two areas of knowledge i.e., pedagogy, specifically differentiated instruction approach (in the teaching of mathematics); and gifted and talented education. In general, this study reveals that gifted students, if given appropriate differentiated mathematics lesson, could perform better academically as the differentiated activities provided have had a significant impact on the students' mathematical thinking process. Specifically, this study sheds significant light especially for the teachers in order to better prepare their differentiated lessons for the students in the future.

## 1. Introduction

Differentiated instruction (Di) has become the predominant mode of pedagogy in most educational institutions in their teaching and learning practices. It is seen as the best way for teachers to know their students in terms of their knowledge base, preparation levels, language proficiency, learning priorities, interests and learning methods. This knowledge enables teachers to approach teaching and learning activities differently for students with varying skills in the same class, to maximize each students' performance (Tomlinson. et al. 2005). Teachers play a vital role in ensuring that differentiated teaching and learning activities take place effectively in their classrooms. In addition to selecting the most appropriate teaching activities and strategies for each student in the class, the teacher's awareness of the teaching philosophy here is essential. Five factors describe the current situation related to differentiated instruction from the teachers' perspective; these include 1) teaching philosophies and practices related to growth, mindset and ethics , 2)flexible grouping, 3) the principle of output matching input, 4) teaching tailored to suit students' interests and readiness and 5) learning profiles. . Students' interests, preparedness and learning profiles are all taken into consideration when designing instruction , which ensures that the most effective learning occurs for the most number of students (Tomlinson 2017). When it comes to classroom teaching and learning, it has been shown that differentiated instruction increases motivation, strengthens bonds between instructors and students and narrows success gaps. However a number of flaws need to be addressed, including the shortage of well-trained instructors, confusion in differentiated instruction, big numberof students in the class, poor course structure and training for teachers, as well as inadequate classroom equipment (Kamarudin et al. ; Ginja et al. 2020). With the differentiated instruction method, instructors may practise teaching in a more flexible and adaptive setting than they were previously able to do so. It is becoming increasingly popular due to the fact that this form of teaching is more effective on work generated by students in the classroom. The majority of students will seek to utilise their own talents and interests in order to study new material that has been presented by the instructor, in order to assess new knowledge. This is also the case when it comes to teaching mathematics, particularly in secondary schools. With the utilisation of problem-solving exercises, which are a critical component of this method, instructors have the opportunity to help their students in learning about the process of mathematical reasoning. When presented with a problem, mathematicians can think in five distinct ways, depending on the situation they are in. It is important for students to be aware of the five basic ways in which they can think mathematically, so that they can demonstrate their ability to connect ideas or concepts in mathematics with mathematical problems that need to be solved. The following skills are demonstrated in mathematics by students: students can develop and present an idea to teachers and peers, students can communicate concepts or ideas clearly and effectively, students can come up with mathematical proof through reasoning and express them mathematically and students are able to solve the mathematical problems that they have been presented with Scusa (2008). When it comes to differentiated instruction in the classroom, it should be designed and implemented in line with the learning cycle model illustrated in Figure 1, as well as other factors that should be taken into consideration. The model illustrates an appropriate process as well as the concept of mathematical thinking being practised, both of which are beneficial. Teachers can organise lessons around the five processes that have been outlined above by allowing students to deliver a presentation on their learning objectives as part of their classroom instruction. Thus, students can gain experience in connecting mathematical ideas or concepts with mathematical problems, presenting pertinent information in a relevant manner, communicating mathematic ideas and concepts, formulating mathematical arguments and proof and subsequently solving the mathematical problems that they are required to solve. There are a number of suitable mehtods for this Di approach and educators are given the opportunity to practise this mathematical way of thinking. The process of Di which begins with the pre-test, continues with group division (flexible grouping) and concludes with the post-test may be used to teach students how to think mathematically. This model is adapted from the model of learning cycle and decision factors used in planning and implementing differentiated instruction (Purcell et al. 2002).

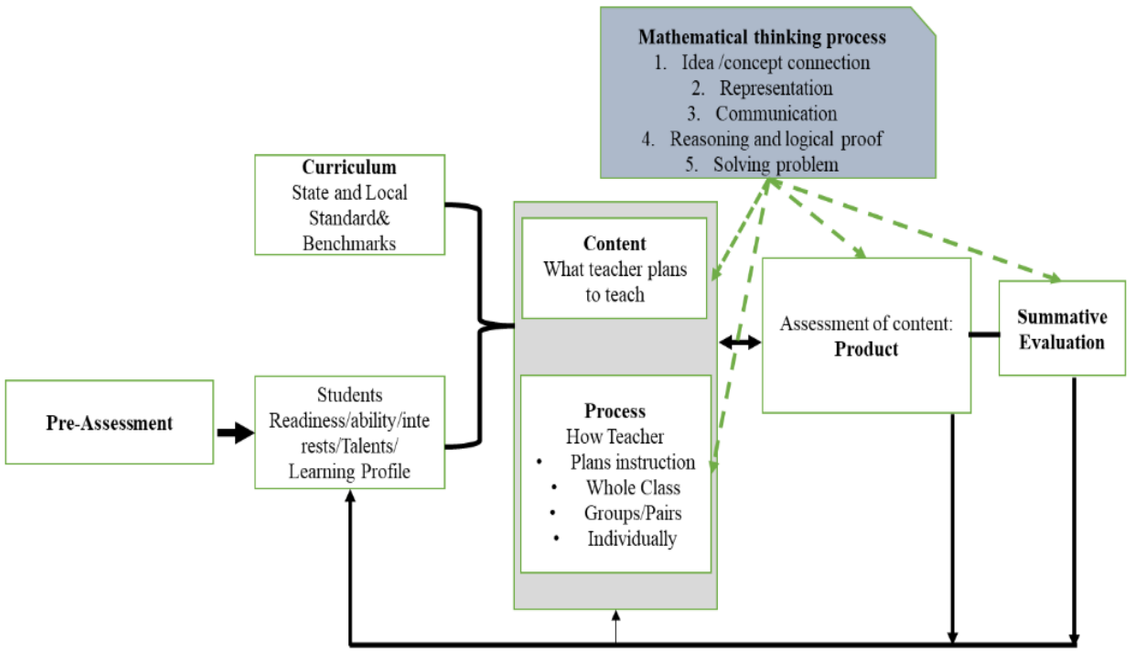


**Figure 1.** Learning cycle and decision factors used in planning and implementing differentiated instruction

When we talk about "gifted and talented children," we are referring to children or adolescents who have exceptional ability and potential in a variety of areas, such as intellectual, creative, academic (including leadership), performance and visual arts (including visual arts); all age groups of children and teenagers can be included in this category. Traditional teaching and learning activities practiced in schools are also necessary to meet the educational needs of these gifted and talented children (Heller et al. 2004; Parke 1981; Renzulli et al. 2004). When it comes to running a successful program for gifted and talented children, one of the most crucial components is educating instructors on the potential and ability of these students, particularly those who are intellectually gifted and talented.

For the past 10 years, by collaborating with the Universiti Kebangsaan Malaysia (UKM), Kolej GENIUS@Pintar Negara (KGPN) has been working on the establishment of a school in Malaysia that would provide education for children who are both gifted and talented. Those who are gifted and talented are identified through a series of tests administered as part of the Gifted and Talented Identification and Selection System. These tests are categorized into three levels, denoted by the letters UKM1, UKM2 and UKM3, which correspond to the degrees of giftedness and talent attained by the students. KGPN students were selected to attend a school holiday enrichment program before being offered the opportunity to enroll as students at the school. Since 2008, this 'gifted and talented' student education program has made use of the gifted education curriculum developed by experts from several faculties at the National University of Malaysia (UKM) and administered by the university. Differentiated education is also employed by KGPN to teach students who are gifted and very talented (Yassin et al. 2012).

## 2. Literature Review

To make learning more effective, it is important to know how to carry out differentiated instruction to positively impact and improve students' critical thinking processes. Mohd (2019), studied the impact of differentiated instruction on the language and critical thinking skills of 16-year-old students of English as a Second Language (ESL) at full-boarding schools in Malaysia. The results of his research were published in the International Journal of Instruction. Data were gathered from the participants in the study using a variety of methods, including a pre-and post-test and a series of interviews, to get insight into the effectiveness of the new teaching method. An extensive number of modules have been developed in accordance with the national curriculum as well as the language learning styles identified by participants in the study. According to the findings, the new approach had a positive impact on their linguistic proficiency as well as their ability to think analytically.

As part of her research, Azizah (2020) studied the effect of different teaching approaches on students' ability to think creatively and their ability to conduct research on their own. It was seen that different approaches to teaching resulted in placing greater emphasis on the students. Students were provided with options to independently research a topic of knowledge without help from the teacher. This approach resulted in the effectiveness of learning outcomes being reduced. A study of a variety of teaching strategies was carried out to discover the flaws in the way each technique was carried out in practice. As a result, several problems were fixed, and the results of the study, which was carried out using a quasi-methodological approach to research methodology, showed that students' thinking processes were better off even though they connected to teaching in different ways.

In a related research project done by Al-Shehri (2020) in Abha, Saudi Arabia, the efficiency of differentiated instruction, as well as the development of academic performance and critical thinking abilities among sixth grade students, were investigated. An experimental method was employed in this study, with an educational program being implemented on a sample of 50 students who were purposefully picked from a school in the city of Abha. The results of this study were published in the International Journal of Learning, Teaching and Educational Research. The sample was separated into two groups: the experimental group (n = 25), which received differentiated instruction and the control group (n = 25), which received conventional instructions. Prior to and after teaching, students' academic progress and critical thinking abilities were examined using two tests designed by the

researchers. These tests were administered both before and after the program's execution, and the results were made available to the public. According to the research's findings, after undergoing training through different instruction approaches, the experimental group's academic performance increased; it was found that differentiated instruction raised the students' degree of critical thinking. As a result, the study recommended that this teaching style be implemented across a broad variety of school disciplines and teachers should join in suitable courses in order to increase the efficacy of their instruction in school settings.

According to Kettler (2014) a study was conducted on 45 students who had been identified as intelligent, as well as 163 general education students from three high schools in Texas. The goal of this study was to help enhance the degree of critical thinking skills among fourth grade students; it was conducted in two phases. A statistically significant difference existed between gifted and general education students on the Cornell Critical Thinking Test and the Critical Thinking Test (d = 1.52 and 1.36, respectively) on each of these tests. In the critical thinking process, the data indicated that there were no statistically significant differences between male and female students. The critical thinking scores of children in the three schools did not differ significantly and there were no significant differences in the scores of students in schools that provided gifted education programs. Due to a paucity of evidence regarding the impact of gifted education programs (which did not specifically focus on critical thinking skills) on students from these three schools, it was reasonable to conclude that differentiation in curriculum and teaching methods for gifted students or advanced students did not have a positive effect due to the different teaching methods practiced for all students in the three schools under investigation.

According to Kettler (2021) the development of critical thinking abilities is unquestionably the most constant component of the curricular paradigm in gifted and talented education. Using a different approach to teaching methods, independent learning and critical thinking skills have been integrated into the course content based on the learning objectives. The results reveal that the immersion approach to teaching critical thinking skills is the least successful method since students only gain critical thinking abilities as a byproduct of the immersion experience. On the other hand, the positive influence of differentiated instruction on the curriculum and teaching of critical thinking skills. The goal is to have a beneficial influence on the level of learning children receive, while enhancing the breadth and speed with which gifted individuals master critical thinking abilities. It serves as the foundation for a customized teaching strategy that is designed to help students achieve the program's stated aim of developing advanced critical thinking abilities. Also revealed in this study is that authentic assessment comes from various teaching methods to enhance critical thinking abilities suited to the demands of advanced tasks, with rubrics used to define the degree of critical thinking competency demonstrated by students.

Scusa (2008), showed how to use the mathematical thinking process to solve mathematical problems. It is generally known that not all students are capable of mastering the mathematical courses that are taught in school. To be effective in enhancing student achievement and motivation in mathematical courses, the process of mathematical thinking must be effectively planned and structured. There are five processes that have been identified, and they are as follows: connections; a student who is successful at making mathematical connections and representations; a student who is successful at representation and communication; a student who is successful at communicating mathematically, reasoning and showing proof; a student who is successful at reasoning and showing proof and problem solving; a student who is a successful problem solver.

In the teaching and learning of mathematics, the implementation of differentiated instruction must be paired with the mathematical thinking process to be more effective. Several fundamental aspects in teaching approaches show in a variety of ways that the application of the mathematical thinking process has taken place. They are, for example, independence in learning, openly expressing ideas and thoughts, engaging in activities, encouraging and supporting teachers, flexible grouping and interactive and appropriate assessment. These aspects occur simultaneously with the mathematical thinking process and have helped with students' capacity to answer problems in mathematics by enhancing their mathematical reasoning abilities. The purpose of the present study is to determine the level of efficiency of all the above aspects in the differentiated instructions approach to teach mathematical thinking processes.

## 3. Research Problem

It is essential for students to be able to perform mathematical thinking processes to master the mathematics they are studying in the classroom. There are five processes that have been identified, and they are as follows: connections, representation, communication, reasoning and proof and problem solving. Since 2011, differentiated instruction has been implemented in Malaysia's gifted and talented program to improve teaching and learning outcomes (Kamarudin et al. 2018). Through differentiated instruction, students' characteristics such as interests, preparedness and learning styles are emphasized. Differentiated instruction is implemented in the classroom through the differentiation of four factors, namely the contents, process, product and environment. This teaching approach necessitates teachers' providing activities that are relevant to the characteristics of the students they are teaching. There are numerous factors on the design of activities that require consideration, and these are as follows: independent learning, openly expressing ideas and thoughts, engaging in activities, encouraging and supporting teachers, flexible grouping and interactive and appropriate assessment. This study attempts to investigate if these factors have a favorable influence on the mathematical thinking process as well as the performance of gifted and talented students.

## 4. Research Questions

- What are the activities in differentiated teaching that must be considered to have a relationship with the mathematical thinking process?
- Do the activities in differentiated teaching relate to the mathematical thinking process?

## 5. Research Objectives

- To identify the various aspects of differentiated instruction that are relevant to the mathematical thinking process

- To investigate the relationship between several differentiated instructional components that are connected to the mathematical thinking process

## 6. Methodology

### 6.1. Research Design

This descriptive research is a quantitative study that uses survey methods to ascertain the components of various activities in differentiated instruction and the degree of interaction between these activities and the mathematical thinking process. The first set of data relate to find the effectiveness of differentiated instruction were gathered using a questionnaire that assessed Students' Motivation for learning using Differentiated Teaching in Mathematics. The questionnaire was derived from the Motivational Orientation of Differentiated Instruction in English Language Teaching (MoDiELT). The item was graded on a 5-point Likert scale from Strongly Disagree (1) to Strongly Agree (5). The second set of data is on measuring the degree of using the mathematical thinking process in solving mathematical problems. It comprises two mathematics tests that were administered. The degree to which students master the mathematical thinking process influences their scores.

### 6.2. Research Sample

The questionnaire was delivered to 400 Gifted and Talented students enrolled in the Secondary Education Program at GENIUS@Pintar Negara College, Universiti Kebangsaan Malaysia. Simple random sampling was used to choose the samples. There were 140 Level 2 students (aged 15 to 17 years), 50 Level 1 students (aged 14 to 15 years), 70 Foundation 3 students (aged 12 to 14 years), 70 Foundation 2 students (aged 12 to 14 years) and 70 Foundation 1 students (aged between 12 to 14 years).

### 6.3. Research Instrument

There are nine parts of questions that students had to answer to demonstrate their enthusiasm for motivational orientation toward differentiated instruction in mathematics. It encompasses several components in the differentiated instruction process, including interest: the teacher fulfills the learner's interest in the lesson; readiness: the teacher bases the lesson on the learner's readiness; learning profile: the teacher bases the lesson on the learner's learning profile; the teacher provides for choice, monitors and rewards the learner; instructor prepares the material according to the theme/topics, and the teacher varies the procedure accordingly; flexible grouping: the teacher modifies the grouping style; variable product: the teacher modifies the product and ongoing assessment/adjustment: the teacher offers ongoing assessment/adjustment. Part 1 comprises questions that assess students' feedback on the teacher's handling of instructional strategies in connection to the teacher's activities in fostering students' interest in mathematics lessons. Part 2 consists of five questions that examine students' responses to instructors' proficiency in assessing the degree of student's readiness throughout classroom instruction. While developing these items, the teachers' capacity to organize the lesson in a manner congruent with the students' interests was considered. Part 3 comprises questions that assess students' learning styles, including their comfort with language and activity options. The adjustments were made in accordance with the level of acceptability of the activities among the students, as determined by the teachers. This segment contains twelve questions designed to ascertain children's tolerance for classroom activities that are customized to their learning styles. Part 4 is divided into three sections; it consists of components that assess students' ability to learn independently in the classroom while participating in differentiated activities. Part 5 is divided into two subsections. Seven questions are asked in the survey on teachers' willingness to allow students to express themselves creatively while completing assigned work and whether they are given the opportunity to express their own ideas and opinions. This segment has six items that are intended to assess students' levels of approval for activities related to teaching themes. Part 6, which consists of six items, assesses students' levels of approval for activities related to significant educational concepts. Lessons are varied in content according to their topic, which enables teachers to boost the efficacy of their instruction further. In this segment, students are asked to rate their level of acceptance of the teaching process, which consists of six components. Part 7 is divided into six components, each of which evaluates a student's readiness to engage in teacher-led flexible groups. It comprises six subsections. This study can be used to ascertain the efficacy of teachers' flexible groups and their degree of success. Sections 8 and 9 each contain six questions designed to ascertain the degree to which students accept the exam based on a teacher's review. These sections are based on instructor assessments. Teachers enhance their educational experiences via the use of teaching materials provided by the school system. Each student receives a personalized exam or evaluation based on their own interests, learning styles and readiness.

### 6.4. Data Analysis

SPSS (Statistical Package for the Social Sciences) software was used to analyze the data to discover the relationship between the components of differentiated teaching activities and the mathematical thinking process. The Cronbach's alpha statistical factor was used to determine the consistency of the survey items. Internal Coherence Cronbach's Alpha helps indicate if the data is acceptable. Based on the analysis of the items in the questionnaire, Cronbach's alpha of 0.70 or more indicates that the survey element is consistent and adequate. The coefficient of Cronbach's alpha of the two categories of items for the survey elements is 0.907, which is consistent with the study's conclusions. As a result, the data obtained is highly reliable; the research results can thus be accepted.

## 7. Results and Discussion

Several teaching strategies have favorable impact on the way mathematics is taught in schools. Student-centered approaches, such as students working independently, enjoying small classes, being able to study various topics while working in a group and the work or activities that assist in learning, make the teaching processes more flexible and enjoyable (Stager 2007). Meeting the learning needs of gifted and talented students is difficult since several factors must be considered, not the least of which is the characteristics of the students themselves. It is

necessary to conduct extensive research on the applicability of the activities on students, as well as further research to guarantee that the teaching process works smoothly and successfully. Some of the types of impact on students have been summarized under the six components that describe students' responses to different instructions, which were drawn from the nine sections of items answered in the questionnaire. These components are as follows: independent learning, openly expressing ideas, and thoughts, interesting activities, encouraging and supporting teachers, flexible grouping and interactive and appropriate assessment. The process of mathematical thinking consists of 5 basic components, namely ability to connect ideas or concepts with mathematical problems, communication, representations, formulating mathematical arguments and proof and subsequently solving the mathematical problems.

### *7.1. Correlation between Components of Differentiated Instruction and Scores in Mathematics, Semester 1*

The degree of students' mastery of all 5 basic components is determined by the scores in two examinations, theMathematics Semester 1 examination and Mathematics Semester 2 examination. . The degree of correlation between the components of differentiated instruction and the score of mathematics semester 1 is shown in Table 1. A regression test was used to determine the strength of the relationships and the percentage of impact between these two variables. This table summarizes the values for R and $R^2$ as well as their associated significance levels. The value of R reflects the degree of correlation between the two variables stated, i.e., each component of differentiated instruction, and the mathematics score for semester 1 demonstrates the student's mastery of the mathematical thinking process. While $R^2$ indicates the percentage of effect, the significance value (sig.) indicates how well the regression model predicts the mathematical score. If p value is less than 0.05 then it indicates that, overall, the regression model statistically significantly predicts the outcome variable. According to Table 1, the value of p is 0.000, which is less than 0.05. Therefore, this model's regression is statistically significant in predicting the outcome for each variable.

Each of the six components has an extremely high R value; openly expressing ideas and thoughts shows a value of 0.880; independence learning shows 0.971; flexible grouping shows 0.853; interesting activities shows 0.874; encouraging and supporting teachers shows 0.859 and interactive and appropriate assessment shows 0.924. While the value of $R^2$ for each component is likewise high, this indicates how much effect the differentiated instruction components have on the process of mathematical thinking.

**Table 1.** The Degree of correlation between components of differentiated instruction and the score of mathematics in semester 1

| Student's Responds | R | R Square |
|---|---|---|
| Openly Express Ideas, And Thoughts | 0.880 | 0.774 |
| Independence Learning | 0.971 | 0.942 |
| Flexible Grouping | 0.853 | 0.727 |
| Interesting Activities | 0.874 | 0.764 |
| Encouraging, And Supporting Teachers | 0.859 | 0.738 |
| Interactive and Appropriate Assessment | 0.924 | 0.854 |

Figure 1 show the proportion of variance in the mathematical thinking process. $R^2$ value is the proportion of variance in the dependent variable (mathematical thinking process) which can be predicted from the independent variables (components of differentiated instruction). The results indicate that each component specified differently in the instruction provided a very substantial proportion to the mathematical thought process, as shown in the mathematics examination scores of semester 1(independence learning =94.2%; openly expressing ideas and thoughts=77.4%; interesting activities=76.4%; encouraging and supporting teachers=73.8%; flexible grouping=72.7% and interactive and appropriate assessment=85.4%).

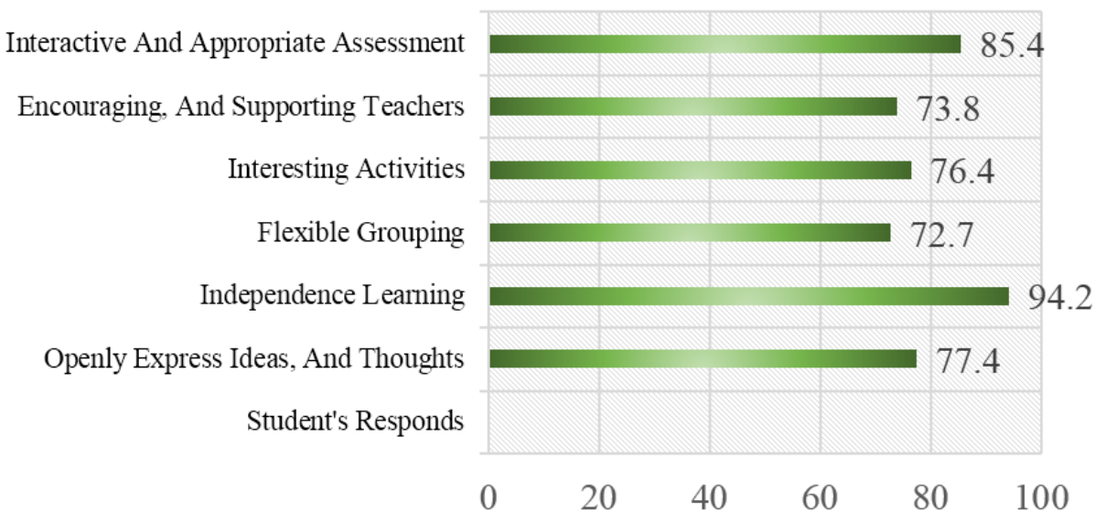


**Figure 1.** The proportion of variance in the mathematical thinking process (mathematics semester 1).

Table 2 shows that the multiple regression model with all predictors produced $R^2 = 0.999$, $F(6.\ 393) = 108959.671$, $p < 0.001$. As shown in Table 2, all components of differentiated teaching have substantial positive regression weights, suggesting that students who scored higher on these scales were projected to perform better in mathematics in semester 1, after taking into consideration other factors.

**Table 2.** Summary of statistics, correlations and results from the regression analysis (Mathematics Semester 1)

| Model Summary | | | | | | |
|---|---|---|---|---|---|---|
| **Model** | **R** | **R Square** | **Adjusted R Square** | **Std. Error of the Estimate** | | |
| 1 | 1.000[a] | 0.999 | 0.999 | 0.270 | | |
| **ANOVA[a]** | | | | | | |
| **Model** | | **Sum of Squares** | **df** | **Mean Square** | **F** | **Sig.** |
| 1 | Regression | 47729.405 | 6 | 7954.901 | 108959.671 | 0.000[b] |
| | Residual | 28.692 | 393 | 0.073 | | |
| | Total | 47758.098 | 399 | | | |
| **Coefficients[a]** | | | | | | |
| | | **Unstandardized Coefficients** | | **Standardized Coefficients** | **T** | **Sig.** |
| **Model** | | **B** | **Std. Error** | **Beta** | | |
| 1 | (Constant) | -0.187 | 0.112 | | -1.668 | 0.096 |
| | C1 | 0.341 | 0.005 | 0.173 | 72.785 | 0.000 |
| | C2 | 0.328 | 0.004 | 0.320 | 84.540 | 0.000 |
| | C3 | 0.343 | 0.004 | 0.176 | 80.993 | 0.000 |
| | C4 | 0.347 | 0.007 | 0.124 | 49.323 | 0.000 |
| | C5 | 0.316 | 0.007 | 0.112 | 47.737 | 0.000 |
| | C6 | 0.335 | 0.005 | 0.197 | 66.771 | 0.000 |

**Note:** a. Dependent Variable: MATHEMATICS RESULT (Semester 1, 2020), eg. 87
b. Predictors: (Constant), interactive and appropriate assessment, flexible grouping, encouraging, and supporting teachers, openly express ideas, and thoughts, interesting activities, independence learning.
Indicators:
C1: openly expressing ideas and thoughts.
C2: independent learning.
C3: flexible grouping.
C4: interesting activities.
C5: encouraging and supporting teachers.
C6: interactive and appropriate assessment.

### *7.2. Correlation between Components of Differentiated Instruction and the Score in Mathematics Semester 2*

Table 3 shows similar results in the association between the differentiated instruction components and Mathematics Semester 2 scores. This test serves as a control variable for the outcomes shown in Table 1. A high R value is achieved by all the differentiated instruction components, which is approximately about the same as what was found earlier (openly expressing ideas and thoughts at 0.876, independent learning at 0.969, flexible grouping at 0.849, interesting activities at 0.872; encouraging and supporting teachers at 0.862 and Interactive and Appropriate Assessment at 0.925). $R^2$ likewise has a high value, with an impact value of more than 70% for each component examined.

**Table 3.** Degree of correlation between components of differentiated instruction and the scores in mathematics in semester 2

| Student's Responds | R | R Square |
|---|---|---|
| openly expressing ideas and thoughts | 0.876 | 0.768 |
| Independent learning | 0.969 | 0.939 |
| flexible grouping | 0.849 | 0.720 |
| interesting activities | 0.872 | 0.760 |
| encouraging and supporting teachers | 0.862 | 0.743 |
| interactive and appropriate assessment | 0.925 | 0.855 |

The degree of variance in the mathematical thinking process is seen in Figure 2. The $R^2$ value indicates the proportion of variance in the dependent variable (mathematical thinking process) that can be predicted from the independent factors (components of differentiated instruction). The findings suggest that each component of differentiated instruction has contributed significantly to the mathematical thinking process as seen from the semester 2 mathematics examination scores (independent learning at 93.9%, openly expressing ideas and thoughts at 76.8 %, interesting activities at76%, encouraging and supporting teachers at74.3%, flexible grouping at72%, and interactive and appropriate assessment at85.5%).

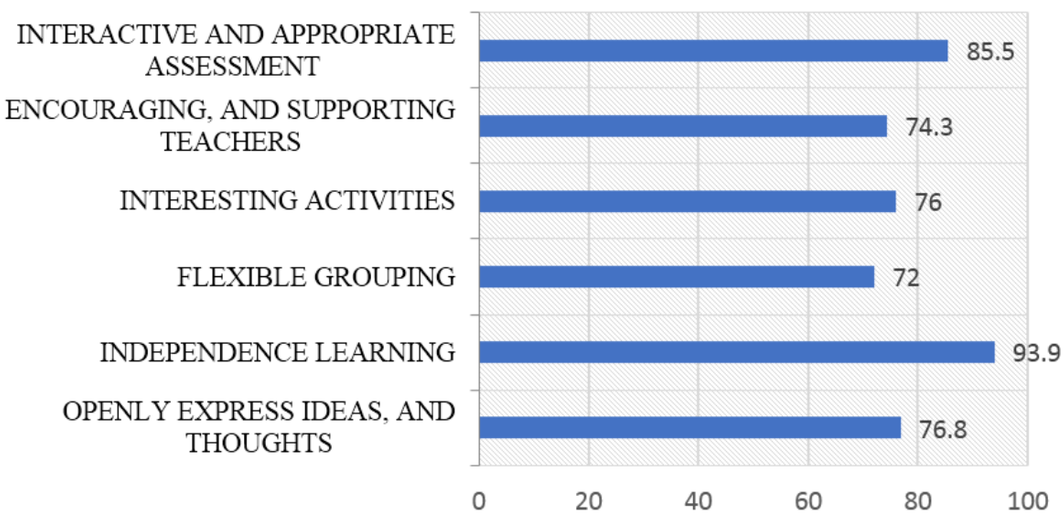


**Figure 2.** The proportion of variance in the mathematical thinking process (Mathematics semester 2).

In Table 4, the multiple regression model with all variables shows R2 =0.996, F (6, 393) = 17991.079, p<0.001. . All components of differentiated instruction have significant positive regression weights, implying that students who scored higher on these measures were projected to do better in mathematics in semester 2 when other model parameters were considered.

**Table 4.** Summary statistics, correlations and results from the regression analysis (Mathematics Semester 2)

| Model Summary | | | | | | |
|---|---|---|---|---|---|---|
| **Model** | **R** | **R Square** | **Adjusted R Square** | **Std. Error of the Estimate** | | |
| 1 | 0.998[a] | 0.996 | 0.996 | 0.340 | | |
| **ANOVA[a]** | | | | | | |
| Model | | **Sum of Squares** | **df** | **Mean Square** | **F** | **Sig.** |
| 1 | Regression | 12503.416 | 6 | 2083.903 | 17991.079 | 0.000[b] |
| | Residual | 45.521 | 393 | 0.116 | - | - |
| | Total | 12548.938 | 399 | - | - | - |
| **Model** | | **Unstandardized Coefficients** | | **Standardized Coefficients** | **T** | Sig. |
| | | **B** | **Std. Error** | **Beta** | | |
| 1 | (Constant) | 52.505 | 0.141 | | 371.932 | 0.000 |
| | C1 | 0.168 | 0.006 | 0.167 | 28.529 | 0.000 |
| | C2 | 0.167 | 0.005 | 0.317 | 34.087 | 0.000 |
| | C3 | 0.170 | 0.005 | 0.171 | 31.973 | 0.000 |
| | C4 | 0.159 | 0.009 | 0.111 | 17.941 | 0.000 |
| | C5 | 0.186 | 0.008 | 0.128 | 22.242 | 0.000 |
| | C6 | 0.180 | 0.006 | 0.207 | 28.507 | 0.000 |

**Note:** a. Dependent Variable: MATHEMATICS RESULT (Semester 2, 2020), eg. 87
b. Predictors: (Constant), interactive and appropriate assessment, flexible grouping, encouraging, and supporting teachers, openly express ideas, and thoughts, interesting activities, independence learning.

The findings of the study show that the activities that have been carried out in the classroom employing differentiated instruction approaches have had a significant impact on the process of mathematical thinking. Component 1 is related to students' ability to express their thoughts and points of view in a variety of ways throughout the teaching and learning sessions. As the mathematical thinking process necessitates communication and idea exchange among students, they must continually communicate with the mathematical ideas and concepts that they are learning. This provides students with the advantage of being able to examine the truth of their ideas, thoughts of views on mathematical notions or concepts that they are familiar with. Component 2 is related to independent learning and the lack of direct instructor direction. This component enables students to be more creative in their application of various mathematical ideas or concepts to solve mathematical problems without exclusively relying on the teacher's techniques. This advantage allows the learner to experiment with different techniques for solving mathematical problems. Additionally, they can perform additional studies on what they have learned in class and its application to everyday situations, particularly problems requiring mathematics calculations. Component 3 is related to grouping in a flexible manner. Students will be able to discuss ideas and opinions more easily and solve mathematical problems in groups because of this group learning. Due to the presence of peers in the group, this setting enhances the learning experience while also expediting the learning process (Stager 2007). Additionally, this group teaching method allows students to choose colleagues who are more comfortable with them, which makes it simpler for them to complete the teacher- directed assignments. Component 4 is related to the exciting activities that teachers provide. Exciting activities encourage students to take the initiative when it comes to preparing presentations or discussing ideas with others. This has a significant positive impact on the mathematical thinking process in terms of communication and presentation of concepts. Planning activities that are a good fit for the students' learning styles will improve their focus and enjoyment while completing given tasks. Component 5 is on teachers' continual encouragement and support. By teaching differently, instructors take on the role of facilitators, ensuring that teachers are fully prepared to teach in terms of teaching materials, training, activities and other areas. This preparedness is critical for students to enhance the learning process which assists them in connecting mathematical ideas and concepts as well as solving mathematical problems. Component 6 is concerned with interactive assessment. It is directly associated with students' ability to construct mathematical arguments and proof. Teachers must design homework and examinations that are appropriate with the students' characteristics and interest. This condition enables students to freely develop their mathematical formulae and proof for addressing the problems that need the use of wider mathematical ideas and concepts. All these components contribute to the satisfaction and effectiveness of instruction and have a good effect on the development of the mathematical thinking process.

## 8. Conclusion

Mathematics demands a systematic and rigorous approach to instruction. The five processes indicated above are the most effective strategies for guaranteeing that any students can successfully learn and master mathematics. To guarantee that this mathematical thinking process occurs smoothly, it is imperative that teachers spend the required time to plan the lesson. In this instance, a differentiated instruction approach is the most effective way to expose gifted and talented students to the mathematical process.

The findings indicate a strong correlation between differentiated instruction and the mathematical thinking process. Responses from gifted and talented students about differentiated instruction activities have been summarized in the form of the six components mentioned above (independent learning, openly expressing ideas, and thoughts, interesting activities, encouraging and supporting teachers, flexible grouping and interactive and appropriate assessment). All these components contributed to the achievement of the semester 1 and semester 2 mathematics examination results in this study. The math results of semester 1 and semester 2 show how well the mathematical thinking process works (able to connect ideas or concepts with mathematical problems,

communication, representation, formulating mathematical arguments and proof and subsequently solving the mathematical problems).

Thus, it can be concluded that differentiated instruction has a significant and favorable influence on the mathematical thinking process. Instructors must ensure that class preparation, particularly activity design, is based on the six components stated above: independent learning, openly expressing ideas and thoughts, interesting activities, encouraging and supporting teachers, flexible grouping and interactive and appropriate assessment. Teachers must ensure that all the components listed above are implemented throughout the teaching and learning process, to enhance mathematical thinking processes in gifted and talented students. Additional studies are needed to discover which activities should be carried out to have a direct impact on students' mathematical thinking processes, as well as which activities should be avoided.

## References


Al-Shehri, M. S. 2020. Effect of Differentiated Instruction on the Achievement and Development of Critical Thinking Skills among Sixth-Grade Science Students. *International Journal of Learning, Teaching and Educational Research* 19(10): 77-99.

Azizah, D. 2020. Application of Differentiated Instruction to Students' Creative Thinking Ability. *Delta: Scientific Journal of Mathematics Education* 4(1): 1-8.

Kamarudin, M. F., Bin Kamarulzaman, M. H., Aznin, M. S., Bin Mohd Sharif, M. M. S., Saali, N., Esrati, M. Z. & Negara, P. P. Motivational Impact of Differentiated Instructions in Mathematics among Gifted Students.

Ginja, T. G. & Chen, X. 2020. Teacher Educators' Perspectives and Experiences Towards Differentiated Instruction. *International Journal of Instruction* 13(4): 781-798.

Heller, K. A. & Hany, E. 2004. Identification of Gifted and Talented Students. *Psychology Science* 46(3): 302-323.

Kamarudin, M. F. B., Kamarulzaman, M. H. B. & Ishak, N. M. 2018. The Relationship between Gender, Age, and Attitude toward Mathematics among Malaysian Gifted Students. *The Educational Review, USA* 2(8): 410-416.

Kettler, T. 2014. Critical Thinking Skills among Elementary School Students: Comparing Identified Gifted and General Education Student Performance. *Gifted child quarterly* 58(2): 127-136.

Kettler, T. 2021. A Differentiated Approach to Critical Thinking in Curriculum Design. Dlm. (pnyt.). *Modern Curriculum for Gifted and Advanced Academic Students,* hlm. 91-110. Routledge.

Mohd, S. N. E. 2019. The Effects of Differentiated Instruction on Students' Language Attitude and Critical Thinking in an Esl Context.

Parke, B. N. 1981. Identification of Gifted and Talented Students. *Journal of Career Education* 7(4): 311-317.

Purcell, J. H., Burns, D. E., Tomlinson, C. A., Imbeau, M. B. & Martin, J. L. 2002. Bridging the Gap: A Tool and Technique to Analyze and Evaluate Gifted Education Curricular Units. *Gifted child quarterly* 46(4): 306-321.(

Renzulli, J. S. & Reis, S. M. 2004. *Identification of Students for Gifted and Talented Programs.* Corwin Press.

Scusa, T. 2008. Five Processes of Mathematical Thinking.

Stager, A. 2007. Differentiated Instruction in Mathematics.

Tomlinson, C. A. 2017. *How to Differentiate Instruction in Academically Diverse Classrooms.* ASCD.

Tomlinson., C. A. & Strickland, C. A. 2005. *Differentiation in Practice: A Resource Guide for Differentiating Curriculum, Grades 9-12.* ASCD.

Yassin, S. F. M., Ishak, N. M., Yunus, M. M. & Abd Majid, R. 2012. The Identification of Gifted and Talented Students. *Procedia-Social and Behavioral Sciences* 55(585-593.