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# Meeting the Needs of Gifted and Talented Students using Differentiated Instruction in Enhancing Chemistry Understanding

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**Abstract**

Differentiated instruction is the practice of tailoring instruction to meet the different needs of students. Differentiated instruction basically help to fulfil 'no child left behind' concept. This research aims to explore the use of differentiated instruction approaches in learning chemistry. The respondents of this research comprised of 132 respondents who were chemistry learners from science background, taking chemistry subject as their core subject within the programme. Quantitative and qualitative studies were conducted. The quantitative data were analyzed using SPSS 21.0 to identify significant improvement in students learning and understanding using t-test. Qualitative method was employed to obtain students' perception on differentiated instruction. Atlas.ti software was used to analyze qualitative data. Based on the analysis, a significant improvement was observed in post-test compared with pre-test. Moreover, t-value was found to be significant, with $p<0.05$ and this indicates a significant improvement in students learning and understanding of the chapter. Generally, different level of students, namely struggling group, medium group and advance group students gives a positive feedback on differentiated instruction. This paper may help to bring about changes to improve chemistry teaching and learning processes among educators.

**Keywords:** Differentiated Instruction, Gifted And Talented Students, Enhance, Chemistry

## Introduction

Recently, the 21st-century learning has been developed in order to fulfil the students' competencies in facing real live challenges (Rahmawati, 2019) and updated with the technology (Doebler, 2011). Rich (2010) proposed that in the 21st-century learning, the students are required to master content of the subject besides producing, synthesizing, and evaluating information. Thus, the teachers are found to be face a great challenge in order to prepare the students towards 21st –century learning, especially students with a wide range of abilities, the gifted and talented students in Chemistry.

## Challenges in Chemistry Classroom

Generally, Chemistry as a subject is categorized as conceptual compare with other science subjects such as Biology and Physics (Taber, 2019a). Taber (2019a) also states that Chemistry is a 'practical' subject. Chemistry as a practical subject is applied in daily activities and provide

intrinsic understanding of the natural world (Sederio et al., 2021). At school or universities level, chemistry is introduced to students with a wide array of concepts (Taber, 2019a). Moreover, students also were used to teach for passing the test by memorizing the chemistry facts and ignoring the concepts. This cause chemistry learning becomes difficult and less meaningful among the students (Rahmawati, 2019).

Taber (2009b) found that one of the extensively perceived issues in teaching chemistry is that students very frequently develop alternative ideas about science topics. Various description namely alternative conceptions, conceptual frameworks and intuitive theories was proposed by the researchers for these alternative ideas, however, but these descriptions are commonly referred as misconceptions (Taber, 2009b). Moreover, Ali (2012) conducted a study to identify the common difficulties in chemistry classroom faced by high school students in Gilgit-Baltistan region of Pakistan. The study found that the main obstruction faced by the students is inability to demonstrate a good understanding of very basic concepts of chemistry.

Furthermore, Taber (2009a) highlighted that learning chemical concepts is not straightforward. Students at all levels often do not understand or only partially understand or indeed misunderstand the key concepts in chemistry. Students in these situations are found to be confused or do not understand what is being taught (Taber, 2019a). According to Beaumont (2013), similar like other subjects, Chemistry learning students facing challenges when students' diversity was not addressed. Thus, to address the problem, it is crucial to develop the most relevant curriculum and teaching strategies (Eilks and Hofstein, 2015) to effectively suit the students learning styles and individual needs.

**Gifted and Talented Students in Traditional Chemistry Classroom**

Sederio et. al (2021) states that in a Chemistry classroom, lecture style will be used to present information and provide similar laboratory instruction to all. This traditional way of lecture style was found to be good for students who have good attention, logical and analytical thinking. This finding is similar to those highlighted by (Koeze, 2007). Based on Koeze (2007), in the traditional classroom, one lesson designed to meet the needs of all the students causes increase in number of failing students. In a worse situation, Anderson (2007) highlighted that when the content doesn't create interest towards the subject or the material provided by the teacher is unduly hard to understand, the students tend to leave the course. Thus, the idea of the one size fits all curriculum was found to be not appropriate and no longer meets the needs of the majority of learners (McBride, 2004).

In the case of gifted students, it was found that they have ability to excel in school, however, researchers have identified that approximately 50% of the middle school gifted students are under underachieving category (Chinnis, 2016). Moreover, in another study to reverse underachieving behaviour of gifted middle school student, Ritchotte et. al (2015) found that student behaviours become a problem for underachieving and a distraction in the classroom. In some cases, gifted students become bored due to unchallenged school curriculum (Kanevsky & Keighley, 2003; Merriman, 2012) and noncompliant in completing assignments since from gifted students view the assignments are pointless (Merriman, 2012).

Generally, the needs of all students should be met in education classrooms, but this is not always true in the case of gifted students (Schultz, 2002). Brulles & Winebrenner (2011) states that "gifted students often are those who are the least likely to experience academic growth" with the traditional classroom settings and teaching strategies. In order for the gifted students to stay motivated and perform to the highest potential, it is crucial for educational systems to meet their special needs (Taucei et al., 2015).

Based on researchers, years ago teachers had different grade levels and different learning abilities students filled at one classroom (Anderson, 2007). Research also shows that a typical classroom able to narrows students thinking strategies and answering options (Jensen, 1998). According to Nicolae (2013), by looking at a typical classroom and the ability levels within it, one can conclude that teachers who do not differentiate teach only a fraction of their students (Nicolae, 2013). The teacher needs to identify the learning needs of all the students. Failure to recognize and resolve this situation leads to loss of potential students in the classrooms (Wehrmann, 2000).

**Contribution of Differentiated Instruction to Academic Performance**

Differentiated instruction for gifted students in the classroom was found to be one of the modern teaching and learning pedagogy in science instruction which able to improve the academic performance of the students. Maxey (2013) conducted a qualitative study to examine the effect of differentiated instruction in mathematics achievement among the second grade primary school students on a United States military base overseas. Result indicates that there was a significant difference in acquiring good grade among ability groups (high, average and low) students and benefitted the most from differentiated instruction. It was found that the research able to assist the educators to identify the most effective method in improving mathematics grade.

A quantitative study was conducted by Aliakbari and Haghighi (2014) involving 47 elementary students of a language institute in Iran shows that students from experimental group accomplish great achievement than control group. Little (2014) examined the effects of differentiated and the study significantly excellent performance than control group in terms of reading fluency at two of the schools.

Pablico et al (2017) conducted a study to determine the effect of differentiated instruction on learning outcomes of high school science students. A positive perception about differentiated instruction was obtained based on personal interviews with six science teachers.

In another study to investigate the performance of students in Chemistry as exposed to differentiated instruction using Tiered Lessons and traditional approach measured in terms. The study suggest that differentiated instruction via Tiered Learning is an effective approach in the teaching and learning of Chemistry (Tadifa, 2017). Studies as shown that, in Malaysia research on differentiated instruction mainly observed on gifted and talented students, exploring the effectiveness of differentiated instruction on STEM subjects (Ismail & Aziz, 2019), with limited exploration on lesson plan for differentiated instruction. Therefore, this study aimed to explore the use of differentiated instruction approaches in chemistry focusing on content and product differentiation and the students' perception on differentiated instruction.

**Methodology**

The respondents of this research comprised of 132 respondents, aged 15 years old who were pursuing their Junior School Certificate in Pusat GENIUS@Pintar Negara in Selangor, Malaysia. All the selected respondents were chemistry learners from science background, taking chemistry subject as their core subject within the programme. The study was conducted during the first semester of 2022 academic year, from April to June.

This study employed both quantitative and qualitative methods of research. The lesson plan was prepared for the topic rate of reaction, where pre-test and post-test was conducted

prior to the lesson. The lesson plan was prepared according to the guideline proposed by Pusat GENIUS@Pintar Negara, in a differentiated classroom. The activities were proactively planned and carried out with varied approaches in terms of content and product in anticipation of and response to student differences in readiness, interest, and learning needs. The SPSS 21 software was used to analyze the data. Interviews were conducted in order to further support and verify the survey data.

Qualitative method was employed to investigate the perception of student on differentiation practice. A list of open-ended questions was prepared and organized before semi-structured interview. The interviewees' contribution to the research was informed in order to encourage them to participate. An interview protocol was prepared in order to fulfill the aims of the interviews. Semi-structured interview was used due to its flexibility in terms of the options for further questioning of a particular respondent. However, interviewees were also free to share new ideas or opinions throughout the interview. The qualitative data were analysed using Atlas.ti.

## Results and Discussion

### Prior Assessment

A pre-test and post-test was administered to identify respondents' abilities on the topic, Rate of Reaction before and after the lesson. A primary reason for pre- and post-test was to figure out the degree to which students have learned and understand the content of the topic. The pre-test and post-test covers several multiple choice questions to gauge respondents' prior knowledge of concepts addressed in the chapter, Rate of Reaction. Figure 1 shows the mean value for pre-test and post-test of the respondents. On the other hand, Figure 2 represents pre-test and post-test result of the respondent and differentiated instruction was implemented. Based on the data obtained, a significant improvement was observed in post-test compared with pre-test. Thus, administering pre-test before lecture is highly encouraged to enhance the curiosity, concentration and enthusiasm to learn among the students. This is because pre-test assist the students to gain new knowledge (Shivaraju, 2017).

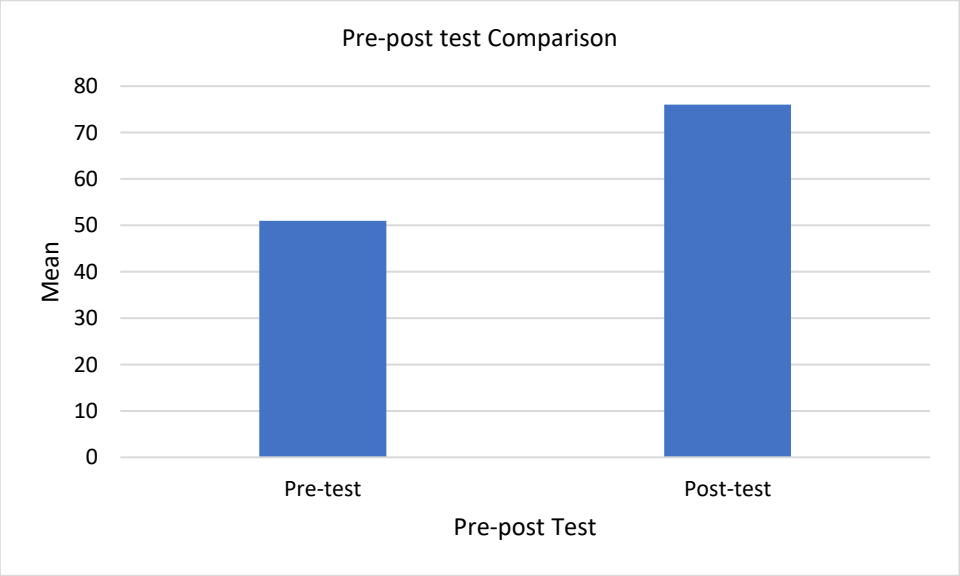


Figure 1: Mean value of the pre-test and post-test

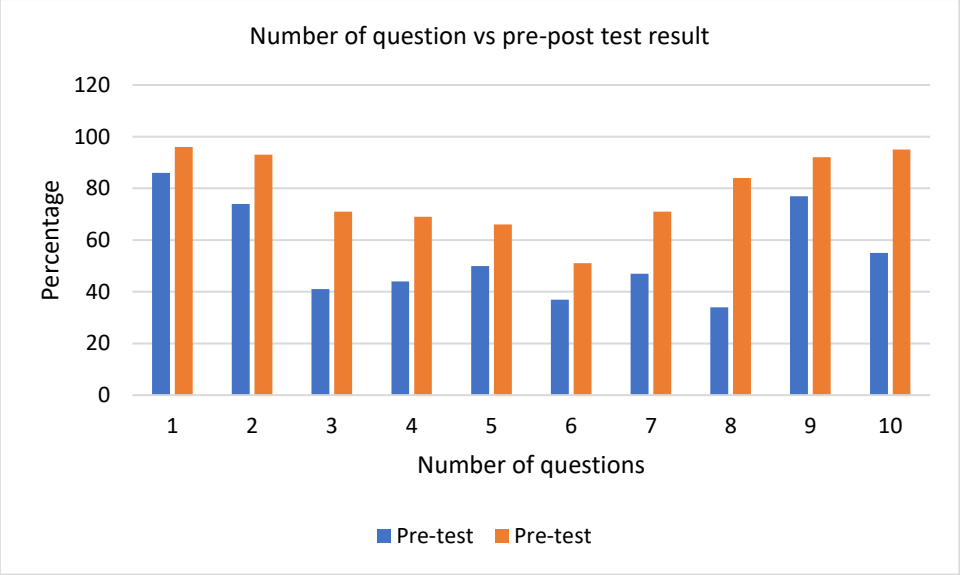


Figure 2: Respondents' academic performance based on pre-test and post-test

Table 1 represents the t-test analysis for paired samples. Based on the analysis, the t-value was found to be significant, with $p<0.05$. Thus, in can be concluded that there was a significant improvement in students learning and understanding of the chapter, Rate of Reaction. Moreover, if students have good understanding about Rate of Reaction, they will begin to focus on the key topics that will be covered in the topic. This finding is in agreement with the findings of (Shivaraju et al., 2017). Based on Shivaraju et al (2017), pre- and post-test act as a triggering point to encourage the student to study further by improving students' focus.

Table 1
*T-test for paired samples*

| | | Paired Differences | | | | | t | df | Sig. (2-tailed) |
|---|---|---|---|---|---|---|---|---|---|
| | | Mean | Std. Deviation | Std. Error Mean | 95% Confidence Interval of the Difference | | | | |
| | | | | | Lower | Upper | | | |
| Pair 1 | Pretest - Postest | -25.806 | 22.624 | 4.063 | -34.105 | -17.508 | -6.351 | 30 | .000 |

**Differentiated Activity in the Classroom**

Before the beginning of the class, the result obtained using pre-test was used to group the students as a part preparation for differentiated instruction in the class. Pre-test result also assist the teacher to address individual needs since new concepts were presented in Rate of Reaction. Moreover, the result from pre-test and post-test was found to be useful to identify the strengths and weaknesses of the students in order to provide continuous support during the lesson. The differentiated instruction class was conducted in a small group instruction mode to support the individual learning needs of the students based on their performance on the pre-test. For the topic Rate of Reaction, the students were differentiated in terms of content and product.

Students were given different level of instruction based on their pre-test score. Teaching same material at varying level instructional strategies is crucial to fulfil the ability of each gifted and talented students. At the beginning of the lesson, the students were given a basis introduction about rate of reaction and collision theory. The mix ability group students were divided into small groups to learn more about rate of reaction and collision theory. For struggling group (Group 1), the students were asked to investigate type of reaction and the factors to speed up a chemical reaction. While, for medium range group (Group 2), the students were asked to investigate the effect of various factors on the rate of reaction based on collision theory. Lastly, the advanced group (Group 3) students were asked to evaluate and assess collision theory based on everyday activities. All the groups were given freedom to demonstrate the knowledge and understanding.

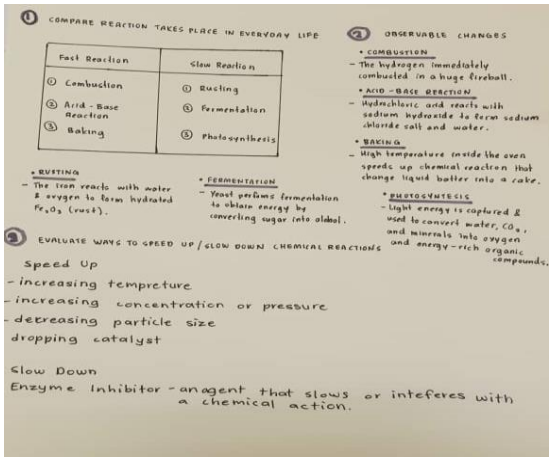

Figure 3: Product from Group 1 (Listing)

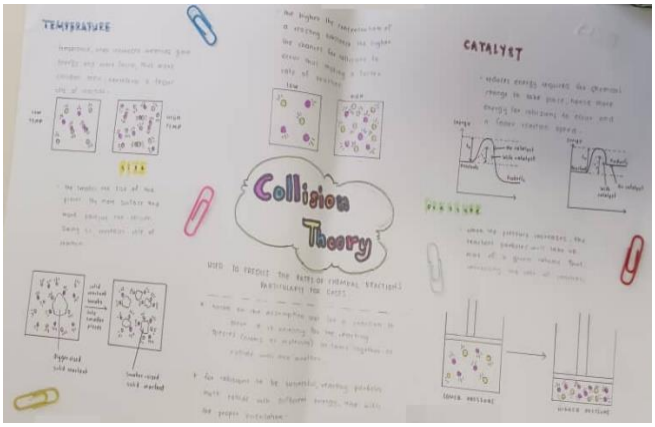

Figure 4: Product from Group 2 (Mind map)

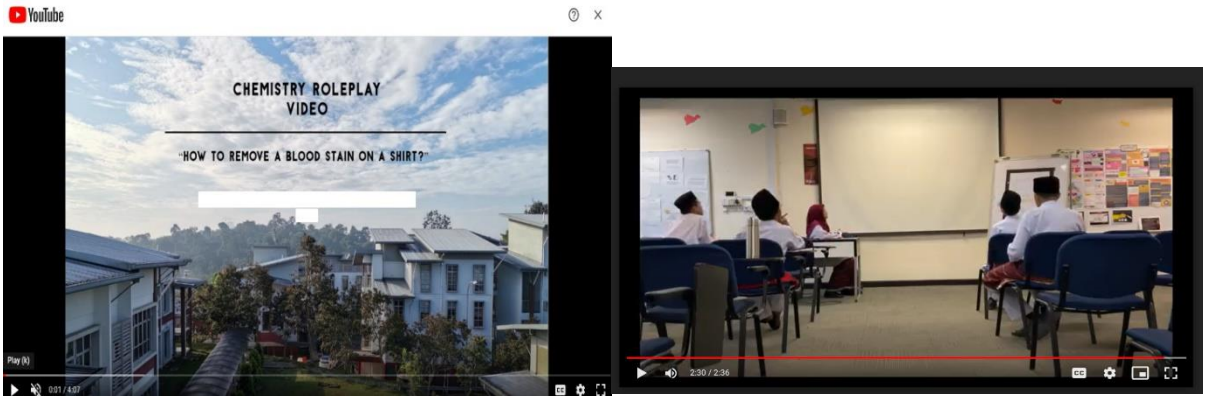

Figure 5: Product from Group 3 (Video)

The product obtained from each group shows the efforts of the mix ability group students in understanding and knowledge into best learning environment possible. Although the teacher act as a mediator, the students able to connect the knowledge gain into daily life and demonstrate based on their creativity. Thus, understanding of students' ability is crucial for greater student engagement with the content and to grow in their learning in differentiated instruction. In line with previous research, in differentiated teaching understanding the strength and weakness of each student's potential allows for a more thorough individualized differentiated learning plan for each student (Brualdi, 1998).

**Students' Perception on Differentiated Instruction**

In the classroom, it was found that differentiation consists of the efforts of teachers to respond to mix ability group of students. Loreman (2017) described differentiated instruction as an instructional strategy which allow teachers to ensure that all students have positive and successful learning situations with optimal learning outcomes. The effectiveness of differentiated instruction is often correlated with academic performance and achievement of the students (Loreman, 2017). Table 1 shows the students perception on differentiated instruction.

Based on interview, Student A from struggling group appreciate the use differentiated instruction in chemistry classroom. This is because they feel comfortable working together with their own level of group. According to Student B who is from average group, states that differentiated instruction enables them to receive additional attention from their instructor, especially when they have low level of understanding about the particular topic. From the students' perspective it is noted that differentiated instruction able to motivate the students via active engagement in the classroom. However, the teachers playing crucial role in providing opportunity and interactive path way via differentiated instruction in order for the students to learn at their own level of understanding. Additionally, Burn (2014) also demonstrated that differentiated instruction able to increase the students' interest and participation to the lesson. Thus, frequent use of differentiated instruction in teaching led to a higher level of motivation among the students (Guay et al., 2017).

Student C, from advanced group highlighted that learning the topic that they already know is boring and differentiated instruction enables them to work in their own pace with own preferred topics. Student D, from advanced group states that differentiated instruction is an interesting way to help students to explore more about certain topic. Student D also pointed that the Chemistry lesson become more meaningful when the instructor challenges the students and this leads them to explore more. The findings reveal that differentiated instruction has positive effects to the advanced group students and the students had positive attitudes towards learning chemistry. Bender (2012) further supports that the role of teacher as a demonstrator, role model, instructor is crucial to assist the students apply necessary knowledge and skills. Eventually, the students able to process and apply the content they learn in a creative way.

Table 1
*Students perception on differentiated instruction*

| Struggling Group | Average Group | Advance Group |
|---|---|---|
| Appreciate the use differentiated instruction in chemistry classroom | Enables them to receive additional attention from their instructor, especially when they have low level of understanding about the particular topic. | Enables them to work in their own pace with own preferred topics. |
| | | An interesting way to help students to explore more about certain topic. |

**Conclusion**

Differentiated instruction is a beneficial teaching approach to address mix ability group students. It acts as a tool to students to be self-directed and creative in obtaining new

knowledge in Chemistry by using core principles and concepts. In order for all the students to experience successes that matter to them, chemistry subject must accommodate individual differences of talent and development. Students give positive feedback on implementation of differentiated instruction, although differentiated instruction requires detail planning and time. The findings of this study desire for more research to be conducted into the topic differentiated instruction in Chemistry.

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