

Differentiated Instruction in Chemistry Education

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Abstract

Differentiated Instruction (DI) is a comprehensive approach that addresses a variety of students' requirements and needs in a classroom environment, including their interests, readiness, and learning styles. The idea behind this approach is based on the belief that every classroom is unique. Thus, educators should review and modify their teaching practice from time to time. Hence, this study aims to identify the learning methods in differentiated instruction, their advantages, and challenges to implement in chemistry education using qualitative methods through semi-structured interviews. Seven secondary school teachers with 10 years of teaching experience in Chemistry were selected purposely for this study. To achieve the research objectives, thematic analysis is used, involving reading through the data and analyzing them according to the themes. The experts validate the updated questioning instrument prepared by the researchers to ensure the validity of the questionnaire. Findings reveal that most of them have specific experiences of using differentiated pedagogy to teach chemistry. Three of them described that students, who tend to master visual-spatial intelligence, can interpret and enhance their understanding of a chemistry concept through drawing, namely for the formation of ionic bonds and covalent bonds. For students, who master linguistic-verbal intelligence, teachers can use presentation activities to enhance their understanding of the chemistry concept. Hence, it can promote active learning, encourage students to ask questions, increase students' confidence level in performing classroom activities and other advantages. Conversely, the difficulty faced by the teachers in implementing DI is time constraint. Hence, differentiated instruction is a valuable and practical approach to addressing the diverse needs of students, promoting engagement, collaboration, and the development of essential skills for lifelong learning. Integrating DI principles can contribute significantly to creating enriching and effective learning environments as education evolves.

Keywords: Differentiated Instruction (DI), chemistry education, learning methods, advantages and challenges

Abstrak

Pedagogi terbeza ialah pendekatan komprehensif yang menangani pelbagai keperluan dan keperluan pelajar dalam persekitaran bilik darjah, termasuk minat, kesediaan dan gaya pembelajaran mereka. Idea di sebalik pendekatan ini adalah berdasarkan kepercayaan bahawa setiap bilik darjah adalah unik. Justeru, para pendidik harus menyemak dan mengubahsuai amalan pengajaran mereka dari semasa ke semasa. Justeru, kajian ini bertujuan untuk mengenal pasti kaedah pembelajaran dalam pengajaran terbeza, kelebihan, dan cabaran untuk dilaksanakan dalam pendidikan kimia menggunakan kaedah kualitatif melalui temu bual separa berstruktur. Tujuh orang guru sekolah menengah dengan 10 tahun pengalaman mengajar dalam Kimia telah dipilih secara sengaja untuk kajian ini. Untuk mencapai objektif kajian, analisis tematik digunakan, melibatkan pembacaan data dan menganalisisnya mengikut tema. Pakar mengesahkan instrumen penyoalan yang dikemas kini yang disediakan oleh penyelidik untuk memastikan kesahihan soal selidik. Dapatan menunjukkan bahawa kebanyakan mereka mempunyai pengalaman khusus menggunakan pedagogi yang berbeza untuk mengajar kimia. Tiga daripadanya menyifatkan bahawa pelajar yang cenderung untuk menguasai kecerdasan visual-ruang, boleh mentafsir dan meningkatkan pemahaman mereka tentang konsep kimia melalui lukisan, iaitu untuk pembentukan ikatan ion dan ikatan kovalen. Bagi pelajar yang menguasai kecerdasan linguistik-verbal, guru boleh menggunakan aktiviti pembentangan untuk meningkatkan pemahaman mereka tentang konsep kimia. Justeru, ia dapat menggalakkan pembelajaran aktif, menggalakkan pelajar bertanya soalan, meningkatkan tahap keyakinan pelajar dalam melaksanakan aktiviti bilik darjah dan kelebihan lain. Sebaliknya, kesukaran yang dihadapi oleh guru dalam melaksanakan pedagogi terbeza adalah kekangan masa. Oleh itu, pengajaran yang berbeza adalah pendekatan yang berharga dan praktikal untuk menangani pelbagai keperluan pelajar, menggalakkan penglibatan, kerjasama, dan pembangunan kemahiran penting untuk pembelajaran sepanjang hayat.

Kata kunci: Pedagogi terbeza, pendidikan kimia, kaedah pengajaran, kelebihan dan cabaran

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1.0 INTRODUCTION

Differentiated instruction (DI) is an approach that establishes maximal learning and differentiating instruction with regard to content, process, and product in accordance with student needs in terms of their readiness, interests, and learning profiles (Tomlinson, 2014). Differentiated instruction (DI) aims to meet the learning needs of all students in mixed ability classrooms. Although differentiated instruction (DI) was first thought of as a collection of instructional strategies or as the act of differentiating, it has developed into a pedagogical model with both practical and philosophical elements (Gheysens, 2020). The foundation of this approach is the idea that

variety exists in every classroom and that teachers should modify their curricula accordingly. Differentiation in this topic means the method by which students are held responsible for their skills, aptitudes, rate of learning, and interests outside of the classroom. That is to say, teachers proactively design a variety of activities that address what needs to be taught, how it will be taught, and how students will demonstrate what they have learned. This makes it more likely that every student will acquire as much knowledge as quickly and effectively as feasible. In addition, differentiation is defined by Bearne (2006) as an instructional strategy in which teachers proactively modify lesson plans, instructional strategies, materials, learning activities, and student work to meet the needs of individual or small group students and ensure that all students have the opportunity to learn as much as possible.

Recently, classrooms have grown more diverse, with a more significant number of students from varied backgrounds (Tomlinson, 2015). Teachers use differentiated instruction (DI) to adapt to various students. It is a teaching method that involves teachers making modifications for various students in the class while instructing a range of learners. DI was established on the idea that the curriculum should be adjusted according to each student's particular requirements and interests, with immense respect for their individuality (Schleicher, 2016). For years, teachers and other education professionals have modified instruction (Smale-Jacobse et al., 2019).

DI offers various instructional strategies, including interactive teaching and learning resources. Students' attention will be drawn to an engaging lesson, and they will be more focused throughout. As they want to try applying the content, students who are attracted to entertaining teaching aids will become more engaged in class. Some students always have questions, and this type of learning will provide more connections in their minds. It is inquiry-based learning. An educational approach known as inquiry-based learning focuses on student research, exploration, and questioning to encourage a deeper understanding and the development of critical thinking abilities. By asking questions, researching, and developing connections between ideas, inquiry-based learning enables students to actively participate in the learning process instead of simply giving them the knowledge to memorize. When teaching procedural competencies, assessment and scaffolding work well together to promote differentiation (Baur et al., 2022).

Collaborative learning also promotes a great way of educating students. Collaborative learning is a teaching method that emphasises the collaborative efforts of students working in groups or pairs to achieve expected learning objectives. Students actively collaborate in collaborative learning situations to solve issues, share ideas, and build knowledge as a group. This method encourages interpersonal skills development, teamwork, and communication alongside academic content and understanding the social component of learning. Plus, there has been a lot of focus on cooperative learning and varied teaching because educators and teachers believe these strategies are important for inspiring students and encouraging interactive learning (Ismail & Al Allaq, 2019). Differentiation serves two purposes in the context of cooperative learning which challenges high performers and supports developing learners. When this approach is used, emerging learners believe that they may get help from their peers to go forward and get over obstacles, while high achievers feel that they are valuable contributors to learning.

Differentiated learning also gives lots of advantages. It will increase students' engagement in the learning process because the students are more involved in the learning process and more interacted with the pedagogical activities. They are more likely to be interested in learning the concepts and information being taught. It will also enhance teachers' skills in delivering various subjects. If a teaching environment in a heterogeneous classroom is conducive to students' success (Easa & Blonder, 2022). Rosidah Ramli & Nurahimah (2020) stated that DI allows teachers to celebrate the variation amongst students in terms of their readiness to learn and their background knowledge. Most importantly, the differentiated instruction helps teachers to cater the most suitable learning method based on different students' needs.

Then, students' understanding will become better. It has been proven more successful than conventional instruction in developing students' attitudes toward learning (Rohaeti et al., 2020). Using differentiated instruction techniques in the classroom can make a big difference in students' motivation to learn because they encourage inquiry, participation, and meaningful peer relationships. Better motivation and active students mean improvements in their learning process. High problem-solving and critical thinking levels are a minimum requirement for all students nowadays. DI will enhance problem-solving and critical thinking skills (Leopold & Smith, 2020).

Thus, the findings of this research highlight the advantages of differentiated training as well as its drawbacks. Similar to the opinions described by Hofer & Steininger (2023), several teachers voiced worries about the time limits and burden associated with implementing such techniques, although admitting their potential to improve student involvement and satisfaction. Nevertheless, as Musengimana et al. (2022) point out, most teachers know the benefits of differentiated pedagogy in addressing student needs, sparking curiosity, and accomplishing learning goals in chemistry education. Furthermore, as discussed by Easa and Blonder (2023) and Rohaeti et al. (2020), the benefits of active learning, dynamic classroom environments, and increased student participation further highlight the effectiveness of differentiated instruction in fostering a conducive learning atmosphere.

■ 2.0 LITERATURE REVIEW

Differentiated instruction (DI) is widely used nowadays since it has a lot of positive impact on the quality of education. DI is also getting more attention nowadays since it can assist teachers to understand more about the variety of students' uniqueness and learning styles. Thus, teachers will consider every different interest and learning profile of their students to prepare an effective lesson plan so that the learning input can be transferred to every student (Fatin Nabilah & Muhammad Talhah, 2022).

The main agenda of DI is to assist teachers in catering to the student's individuality and diversity to achieve the same learning objectives (Woolcott et al., 2021). This means that teachers have a lot of choices when initiating learning by using various methods that fit specific topics. They also can change the learning method over time based on students' needs and readiness. For example, cooperative learning can be implemented to increase students' involvement in-class activity and engage active interaction between them. They can also discuss a given task with their group instead of doing individual work, which tends to create a dull learning environment. In other words, DI can be conducted using many types of learning strategies, such as inquiry, cooperative, game-based, and problem-based.

According to Reis & Renzulli (2018), students have their interests, abilities, and prior knowledge. Hence, teachers need to identify their students' needs and ability to understand them better regarding what learning style suits the students. Therefore, there is a practice framework for DI that can act as a guide in performing different learning styles according to the variety of students' needs.

By adjusting teaching to match each student's unique needs, interests, and skills, differentiated instruction (DI) is an essential pedagogical strategy for meeting the various learning demands of students. Significant insights into the justification, advantages, implementation tactics, pedagogical techniques, and assessment of DI have been gained from research in this area. The two main factors that make DI adoption necessary: growing class sizes and the diversification of student demographics (Easa & Blonder, 2022). This variety includes differences in preparation levels, socioeconomic origins, cognitive capacities, learning styles, and cultural influences. The need for teachers to create innovative techniques to address the requirements of all students, those with special needs, in light of the increasing diversity found in classrooms.

A pedagogical strategy called differentiated instruction (DI) is well known for being successful in meeting students' various learning demands. DI places a strong emphasis on adaptation and customisation in teaching techniques since it is based on the idea that a one-size-fits-all education is insufficient to meet the diverse talents, interests, and backgrounds of students (Rock et al., 2008). DI strives to establish inclusive learning environments where all students may succeed by customising education to each student's skills, needs, and interests. Encouraging flexibility in content, procedure, and product is at the heart of differentiated instruction (Adams et al., 2019). This entails providing many avenues for students to interact with the material and access it, taking into account their different learning preferences and styles. DI also stresses how crucial it is to take into account the interests, learning profiles, and preparation levels of the students while creating teaching. DI promotes a more equal and welcoming learning environment by recognising and appreciating student diversity.

Research has repeatedly shown the advantages of using differentiated instruction in schools. Enhancing student involvement, motivation, and accomplishment is one of its main benefits (Reis & Renzulli (2018). DI encourages students to participate actively and learn more deeply by providing material in ways that are relevant to their interests and skill levels. Additionally, DI helps instructors better meet the unique requirements of each student, which enhances academic achievement and fosters a supportive learning environment in the classroom (Woolcott et al., 2021). Differentiated instruction can be implemented in a variety of ways, all of which are intended to meet the unique requirements of students. For instance, tier assignments let students work on assignments with different levels of difficulty according to their preparation level, making sure that every student is suitably challenged (Rohaeti et al., 2020). Students with comparable learning requirements or interests may collaborate dynamically through flexible grouping, which fosters peer learning and support. Choice boards and learning contracts provide students with the freedom to choose tasks or projects that suit their interests and learning preferences, which increases student ownership and participation in the learning process (Baur et al., 2022).

Another valuable tool in the DI toolbox is pre-assessment, which gives teachers information about students' past knowledge, abilities, and preferred methods of learning (Fatin Nabilah & Muhammad Talhah, 2022). Teachers can make informed judgments about their lessons by identifying each student's strengths and areas for improvement through assessments conducted prior to the start of class. By taking a proactive stance when it comes to assessment, instructors better match instruction to the requirements of their students, which maximises learning results.

To sum up, differentiated instruction is a strong foundation for supporting inclusive education and catering to students' various needs. DI provides a route to more engaging, relevant, and productive teaching since it is based on the ideas of equality, flexibility, and student-centeredness. Through the use of Differentiated Instruction, teachers may provide learning environments that afford every student equal opportunities for success.

■3.0 METHODOLOGY

This study was conducted by using a qualitative approach. According to Cresswell (2020), the qualitative approach has the potential to identify the actual situation of one's practice. It very much coincides with this study, which is focusing on investigating the teaching practices among teachers, to ensure that students can master the subject of chemistry, which is often considered as a difficult subject.

The respondents of this study consisted of 7 chemistry teachers around Johor Bahru. The selection of respondents is based on purposive sampling. Chua et al (2019) asserted that the implementation of a qualitative study requires the selection of respondents on purpose. This is to ensure that the selected respondents are able to provide information as required. Therefore, 7 chemistry teachers with more than 10 years of experience were purposely selected to participate in this study to obtain findings related to teaching practices.

Data for this study was collected through semi-structured interviews. The method allows the researcher to ask questions related to the results of the answers given by the respondents. The interview method is one of the best ways that can explore a person's thoughts on a phenomenon experienced. Through the interviews, we can obtain different opinions and answers about their views and experiences towards differentiated pedagogy as teachers since they work in different schools, which have different facilities. Plus, their students also have different levels of academic performance in chemistry.

The questions were mainly open-ended questions relating to information such as their view on differentiated pedagogy, advantages of this method, specific experiences, and so on. Hence, in this research study on implementing DI in Chemistry Education, seven chemistry teachers were interviewed for seven questions that fulfill the elements of differentiated instruction regarding chemistry education as below:

Question 1

What is your view on differentiated pedagogy?

Question 2

In your opinion, is it necessary to implement differentiated pedagogy in teaching chemistry in schools?

Question 3

What are the advantages gained from this differentiated pedagogy?

Question 4

In the context of differentiated pedagogy, how do you engage students with different learning styles?

Question 5

Do you have specific experiences or examples you would like to share in using differentiated pedagogy in teaching chemistry?

Question 6

Have you worked with educators or other support staff to share ideas and strategies about effective differentiated pedagogy?

Question 7

Do you have advice for chemistry teachers who are interested in practicing different pedagogy in their teaching?

An example of an open-ended question included in the interview is, “Do you have specific experiences or examples you would like to share in using differentiated pedagogy in teaching chemistry?” Open-ended questions like these allow the teachers to express their thoughts and feelings that can provide more detail and clearer view on the research objectives. The interviews were conducted via online medium and professionally transcribed; transcripts were analysed inductively, generating significant themes and subthemes. In order to achieve the research objectives, thematic analysis was used, involving reading through the data and analyzing them according to the themes using the frequency (Dawadi, 2020). Not to mention, the experts also validated the updated questioning instrument prepared by the researchers to ensure the validity of this study.

4.0 RESULTS

The findings for seven questions consist of various types of opinions and answers (refer Table 1). This diversity is because each teacher works in different schools, which have different facilities, and students have different levels of performance in chemistry.

Table 1 Findings for seven questions based on the interview conducted.

Questions	Findings	Frequency
Question 1	<ul style="list-style-type: none"> ● Different teaching methods ● Focusing on different parties (students and material centered) 	<ul style="list-style-type: none"> ● 7 ● 7
Question 2	<ul style="list-style-type: none"> ● Should be implemented ● Know important elements in teaching ● Increase students interest ● Achieve learning objectives ● Time constraint 	<ul style="list-style-type: none"> ● 7 ● 4 ● 2 ● 4 ● 2
Question 3	<ul style="list-style-type: none"> ● Active learning ● Fun and Engaging class ● Healthy competition ● More opportunities to ask questions ● More opportunities to answer questions ● Confidence in performing activities ● Increase student motivation 	<ul style="list-style-type: none"> ● 4 ● 3 ● 4 ● 5 ● 4 ● 2 ● 2
Question 4	<ul style="list-style-type: none"> ● Involve students from different achievement categories ● Mix introvert and extrovert students ● Teacher monitor groups by presentation 	<ul style="list-style-type: none"> ● 6 ● 5 ● 5
Question 5	<ul style="list-style-type: none"> ● Have experience in using different pedagogies in the classroom. ● Never use differentiated pedagogy in class ● Acting out the movement of electrons (body kinesthetics) ● Drawing style (visualisation) ● Presentation (verbal-linguistic) 	<ul style="list-style-type: none"> ● 3 ● 2 ● 1 ● 3 ● 2
Question 6	<ul style="list-style-type: none"> ● Have experience ● No experience 	<ul style="list-style-type: none"> ● 2 ● 5
Question 7	<ul style="list-style-type: none"> ● Master the curriculum content first ● Requires a neat lesson plan ● Identify the level of student mastery 	<ul style="list-style-type: none"> ● 2 ● 4 ● 3

5.0 DISCUSSION AND RECOMMENDATION

Regarding Question 1, which asked the seven chemistry teachers who were questioned about their thoughts on differentiated pedagogy, the study findings on differentiated teaching in chemistry education show an agreeable viewpoint. In agreement, all seven teachers emphasised the need to use various teaching strategies to meet the different learning requirements of their students. According to Easa and Blonder (2023), chemistry teachers must use differentiated pedagogy to successfully meet the various requirements of their students and foster successful learning outcomes in classrooms with multiple student demographics.

Additionally, all the teachers emphasised the importance of paying attention to various factors, including students and instructional materials, demonstrating their comprehension of the complicated subject matter of varied instruction in chemistry education. These chemistry teachers' similar answers highlight a common understanding of the need for a thorough strategy of differentiated pedagogy to

improve the efficacy of chemistry education. Differentiated pedagogy, in the mentions of Easa and Blonder (2022), focuses on students and materials. It's a teaching method that considers the students' interests, learning styles, and demands while providing them with as many opportunities as possible to access and interact with the material. Differentiated pedagogy seeks this by making the learning environment more welcoming and productive for all students.

According to Question 2, the seven chemistry teachers who participated in the interviews agreed regarding applying differentiated pedagogy in chemistry classes. Teachers emphasised the value of incorporating differentiated education into their teaching strategies, mainly when teaching chemistry. According to Rohaeti et al. (2020), the choice to undertake differentiated instruction should be based on a careful analysis of the needs and goals of the students and the resources and support available to the teacher and school. Four teachers underlined the importance of identifying the essential elements of differentiated instruction that cater to different learning styles and expertness levels in the classroom.

Furthermore, two teachers within a subgroup acknowledged that a significant consequence of customized teaching might be a rise in students' enthusiasm for chemistry. Chu et al. (2023) imply that these teaching techniques have boosted student engagement and satisfaction with the course. By relating the material to students' interests, experiences, and past knowledge, DI helps make learning more relevant for them. Students are more likely to be interested and motivated to actively participate in the learning process when they realize how what they are studying relates to their own lives. Additionally, DI offers chances for students to receive adequate challenges at their level. Students are more likely to be interested in and motivated to study if assignments are provided that are simple enough and challenging. With DI, assignments may be modified to meet the needs of specific students, guaranteeing that every learner is suitably challenged (Easa & Blonder, 2022). Two teachers voiced worries over the time limits in adopting diversified teaching despite four teachers recognising the necessary role of diverse pedagogy in accomplishing learning objectives. This discussion offers a chance to discuss the real-world challenges of integrating instruction into chemistry classrooms. According to Hofer & Steininger (2023), setting differentiated teaching into practice takes a lot of time and work from teachers for careful planning, the production of resources, and continuous assessment of the requirements of the students. Furthermore, the teacher could take more time and effort to provide each student with customized help. Despite this, most teachers support differentiated pedagogy, citing its advantages in satisfying student needs, igniting interest, and accomplishing learning objectives in chemistry education. Musengimana et al. (2022) state that the extent to which differentiated pedagogy aids students in acquiring the information and abilities required to satisfy the learning objectives should be the basis for evaluating the approach's efficacy in accomplishing learning objectives.

The research study's findings on Question 3 regarding differentiated instruction in chemistry education offer essential facts on its advantages. Four of the questioned chemistry teachers highlighted the benefits of active learning for students' involvement and knowledge. According to Easa and Blonder (2023), implementing differentiated teaching led to a high degree of communication between teachers and students and between students. These encounters positively impacted the degree to which students were motivated, their attitudes, and their level of engagement in the learning process. Engaging students in interactive and participatory activities is a common aspect of active learning, and this definition is consistent with the qualities of active learning within the framework of differentiated teaching.

Furthermore, three teachers emphasised the value of establishing an engaging and dynamic learning environment in the classroom, highlighting the relevance of promoting a pleasant learning climate. Easa and Blonder (2022) mentioned that differentiated education, which adapts teachings to each student's requirements, creates a positive and exciting learning environment. This personalization improves students' comprehension, motivation, and engagement in learning and provides applicability. Differentiated education brings interest to the classroom and increases students' enthusiasm for learning through various exercises and methodologies. Four teachers pushed for healthy competition, claiming it would increase student engagement and drive. DI enables personal development by giving students the freedom to work at their own pace and ability level. This individualized approach may instill a competitive spirit in students, encouraging them to push themselves and make improvements. Students are more likely to be interested and driven to achieve when assigned assignments that are specific to their skills and interests. This competitive spirit is more about defining and pursuing personal objectives than it is about exceeding others. Students are inspired to keep working hard and challenging themselves as they recognize their growth and progress (Easa & Blonder, 2023). Differentiated teaching fosters a cooperative and encouraging learning environment where students may cooperate to accomplish their learning objectives, according to Rohaeti et al. (2020).

Furthermore, as highlighted by four teachers and mentioned by five teachers, diversified instruction generates more chances for students to ask and answer questions, promoting an enthusiastic and dynamic learning environment. By adapting education to a range of needs and learning styles, differentiated instruction creates greater chances for student participation in discussions. This method encourages a dynamic and interactive learning environment by allowing students to ask and respond to questions (Hofer & Steininger, 2023). Two teachers noted that students' increased confidence in finishing assignments highlighted the beneficial effect of diversified teaching on students' self-efficacy. The effectiveness of differentiated pedagogy in building students' confidence in performing activities depends on how well it is implemented and tailored to the specific needs of the students. This approach helps increase students' attitudes toward chemistry, which may include building their confidence in performing chemistry-related activities (Musengimana et al., 2022).

Lastly, according to two teachers, there has been an intelligible rise in student motivation, indicating that this teaching method may improve students' general interest in chemistry. The teachers' recognition of various benefits draws attention to the acceptable benefits of instruction in chemistry education. According to Westbroek et al. (2020), differentiated instruction may increase student motivation. Teachers may provide a more relevant and captivating learning environment through customized education based on each student's unique needs and interests. Students are more likely to be motivated to study if they believe their education is individualized and relevant. Differentiated instruction also encourages a sense of right and responsibility for students' learning by giving them choices and independence in their education, which can boost motivation.

Based on Question 4, six respondents revealed that they would engage students with different learning styles by involving students from different achievement categories in a learning activity. This would encourage them to discuss and guide one another in completing the task given. This collaborative feature creates a safe and encouraging learning atmosphere where students may communicate, exchange ideas, and encourage one another to comprehend and finish the tasks given to them. Teachers assist students in completing the assignments by providing direction and encouragement, encouraging engagement and peer learning (Musengimana et al. (2022). Hence, no one would be left out of the learning process as students with the same academic performance would be separated, and they could learn from each other. One teaching strategy that meets this objective is the jigsaw teaching strategy. It is a cooperative learning strategy that enables

students to become “experts” on different subtopics. After that, they need to share their findings with others. Through this activity, excellent students can help and guide their friends with low academic performance in Chemistry to enhance their understanding of the topic. Besides, it can polish students’ 21st-century skills, namely communication, leadership, and social skills (Ozyalcin & Avci, 2022). Hence, most teachers prefer to engage students with different learning styles by involving students from different achievement categories in a learning activity.

Not only that, five teachers mentioned that they would engage students with different learning styles by mixing introverted and extroverted students. This technique can improve students’ social and communication skills, especially those who are shy and usually quiet in the classroom. Besides, extroverted students can encourage introverted friends to express their opinions and cope with their learning activities. Hence, everyone would take part actively in the learning process. Alasker (2023) supported the idea that introverted and extroverted students have different uniqueness and abilities in academic performance. For instance, in English subjects, it was found that introverted students performed well in listening, reading, and writing skills. On the contrary, extroverted students performed better in speaking skills than introverted students. To enable students to express their comprehension in ways that best fit their communication styles, DI can provide a variety of evaluation options. While extroverted students may grow in group conversations, collaborative projects, and engaging learning environments, introverted individuals may prefer solitary hobbies, introspection, and autonomous study. To satisfy these interests, DI enables teachers to offer a variety of solo and group assignments (Rohaeti et al., 2020). Besides, five respondents highlighted that teachers should monitor groups by presentation to engage students with different learning styles. Thus, teachers can detect students who need more guidance in the learning process.

Findings from Question 5 reveal that all the respondents have specific experiences or examples of using differentiated pedagogy to teach chemistry. Three of them described that students who tend to master visual-spatial intelligence can interpret and enhance their understanding of a concept through drawing, namely for the formation of ionic bonds and covalent bonds. Meltafina et al. (2019) mentioned that students believed that ionic bonding was sharing electrons while there was a transfer of electrons in covalent bonding. They also thought that the atoms of Na and Cl would attract each other to form the compound NaCl. Hence, these misconceptions occurred as students had visual problems understanding this concept. To overcome these difficulties, students who master visual-spatial intelligence can alter their misconceptions about the concept through drawing. Besides drawing, these difficulties also can be solved through role-play activities. Students can act out the movement of electrons to show how ionic bonding and covalent bonding are formed. One of the respondents in this study mentioned this technique, focusing on students who master bodily-kinesthetic intelligence. Besides, three respondents added that for students who master linguistic-verbal intelligence, teachers can use presentation activities to enhance their understanding of the chemistry concept. However, two teachers mentioned that they never used DI in their chemistry class as they have low knowledge and skills to implement it.

From the interview, most respondents have no experience working with other teachers or any support staff to share ideas and strategies about effective differentiated pedagogy, as the level of awareness about differentiated instruction (DI) among teachers is still low. Meutstege et al. (2023) added that most teachers are not too exposed to DI, resulting in a lack of readiness to apply it in Chemistry learning. However, only two respondents shared that they had experience working with other teachers or support staff to share ideas and strategies about effective differentiated pedagogy in science learning. Hence, as the world has morphed to achieve better education quality, teachers need to occasionally play their role in improving their teaching strategies.

Based on Question 7, there is some advice for chemistry teachers interested in practicing different pedagogy. Four respondents mentioned that to implement DI in chemistry teaching, teachers must have a neat lesson plan. Teachers must plan activities to help students achieve their learning objectives and prevent misconceptions about chemistry concepts. Implementing DI in teaching Chemistry may also influence students’ academic achievement (Meutstege et al., 2023). Next, three of the respondents added that to practice different teaching pedagogies, teachers should identify the level of student mastery as they have many abilities to grasp a topic at various levels. Lastly, two of the respondents mentioned that teachers must master the curriculum content first before practicing different pedagogy in their teaching. Teachers must have a strong foundation in chemistry concepts since they are abstract and require deep understanding. Consequently, they can guide students to master the three domains of chemistry learning: cognitive, psychomotor, and affective. Hence, students can increase their chemistry literacy and avoid misconceptions through suitable teaching strategies (Marifa et al., 2023).

The research findings about diversified teaching in chemistry education have wide-ranging implications that highlight the advantages and disadvantages of using this methodology. First, all seven of the chemistry teachers agreed, which emphasizes how important it is to use a variety of teaching techniques specifically designed to fit the different learning requirements of each student. In classrooms with variable student demographics, differentiated pedagogy is essential for meeting the unique needs of students and promoting good learning outcomes. Furthermore, teachers’ attention to elements like student diversity and instructional resources demonstrates a thorough comprehension of the intricacies involved in differentiated education. It highlights the necessity of tailored strategies considering each student’s needs, demands, and interests.

Additionally, the findings of the research highlight the advantages of differentiated training as well as its drawbacks. Similar to the opinions described by Hofer & Steininger (2023), several teachers voiced worries about the time limits and burden associated with implementing such techniques, although admitting their potential to improve student involvement and satisfaction. Nevertheless, as Musengimana et al. (2022) point out, most teachers know the benefits of differentiated pedagogy in addressing student needs, sparking curiosity, and accomplishing learning goals in chemistry education. Furthermore, as discussed by Easa and Blonder (2023) and Rohaeti et al. (2020), the benefits of active learning, dynamic classroom environments, and increased student participation further highlight the effectiveness of differentiated instruction in fostering a conducive learning atmosphere.

The paper also explores practical tactics for implementing diversified education in chemistry classrooms. Practical techniques to meet the unique requirements of students include arranging students according to their learning styles and skills, using visual aids, role-playing exercises, and presentations, and fostering collaboration among teachers. The study also demonstrates a disparity in teachers’ experience and preparedness to apply differentiated education, highlighting the need for professional development and collaboration among teachers. The study’s conclusions underline the significance of individualized teaching in chemistry education for meeting the requirements of a wide range of students, increasing engagement, and accomplishing learning goals. To successfully implement differentiated pedagogy and raise the standard of chemistry education, teachers must collaborate and engage in ongoing professional development. Despite specific challenges, the advantages of personalized approaches and dynamic classroom environments outweigh the drawbacks.

6.0 CONCLUSION

In conclusion, the evolving landscape of classrooms, marked by increased diversity in student backgrounds, has led to the adoption of differentiated instruction (DI) to cater to learners' varied needs. DI, rooted in adjusting the curriculum to meet individual student requirements and interests, has been widely acknowledged as a valuable teaching strategy. Despite its prevalence in education, there has been a notable gap in experimental research, particularly within high school and chemistry classrooms. To address this gap and contribute to the body of DI research evidence, a qualitative approach was employed to investigate the practical application of DI in actual high school classrooms. Interviews with teachers from different schools provided valuable insights into implementing this teaching method.

DI encompasses a range of instructional strategies, including interactive teaching tools and inquiry-based learning. Incorporating engaging and interactive lessons captures students' attention and fosters a deeper level of engagement, particularly for those who respond well to entertaining teaching aids. Inquiry-based learning, emphasizing student research, exploration, and questioning, promotes active participation in the learning process, encouraging critical thinking skills and a deeper understanding. Collaborative learning, another aspect of DI, highlights the importance of students working together in groups or pairs to achieve learning objectives. This method enhances knowledge of academic content and develops interpersonal skills, teamwork, and communication, recognizing the social component of learning.

The advantages of differentiated learning are evident in increased student engagement, improved teachers' skills, and enhanced student understanding. The interactive nature of DI fosters a more profound interest in learning concepts and information, positively impacting students' attitudes toward learning. Additionally, the method has been proven to be more successful than conventional instruction in developing students' problem-solving and critical-thinking skills, which are essential in today's educational landscape. In essence, differentiated instruction is a valuable and practical approach to addressing the diverse needs of students, promoting engagement, collaboration, and the development of essential skills for lifelong learning. Integrating DI principles can contribute significantly to creating enriching and effective learning environments as education evolves.

The limitations for these findings are time constraints and the sample size. The sample size may also be impacted by time constraints. Although larger samples take longer to acquire and analyze, they yield results that are more trustworthy and generalizable. Because of this, when the time is lacking, researchers could choose to work with fewer samples, which can be handled faster but might not yield as reliable of results. Time restrictions might also have a big influence on the study methodology selection. Although they may restrict the breadth and depth of the study, they may also promote effectiveness and concentration, resulting in the choice of approaches that are best suited for the available time. This research uses qualitative method by surveying the respondents and it is taking a lot of time to work on it and the analysis process also took a longer time compared to quantitative method. As a result, when organizing a study methods, we as researchers need to carefully consider the time limits so that we can plan ahead of time on how to conduct the research. We conducted the interview with seven respondents which is the sample size is small and it could be challenging to ascertain if the obtained result represents a real discovery. Hence, some other recommendations can be taken for the future research such as conducting the interview with several teachers that came across from different types of school like cluster school, private school and general school. This is to allow the researchers to collect data from different school's backgrounds and environment to see if there is any significant difference about the teachers' impression regarding DI.

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