Novice Chemistry Teachers' Instructional Strategies in Teaching Mixed-Ability Classrooms

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Abstract: This qualitative study sought to explore Malaysian novice chemistry teachers' experiences in teaching mixed-ability students during their teaching practicum, focusing on their instructional strategies for dealing with those learners in the class. The researchers employed purposive sampling to select 12 trainee teachers to be involved in semi-structured interviews. The data collected were analysed using the constant comparative method. As a result, two themes emerged regarding participants' instructional strategies: the whole-class approach and adjustment to the learners' needs. This paper discusses the first theme, which consists of three sub-themes: active learning activities, the use of stimulating learning materials, and assessment practice. Even though novice chemistry teachers primarily engaged mixed-ability students through whole-class instruction, the study found they emphasised active classroom engagement and collaboration between students in their classroom. Besides, they did consider students' interests and preferences when selecting activities and materials for their lessons. However, the study found that novice teachers mainly did not utilise the data from the formative assessments to inform their decisions in differentiating instruction for mixed-ability learners in class. Though there are differences in students' ability in class, the teachers generally opted for a 'one-size-fits-all' strategy for all students in most lessons. The study recommends that teacher training institutions and related stakeholders provide adequate training for novice chemistry teachers to improve their knowledge and skills in practising differentiated instruction.

Keywords: Differentiated instruction, Diverse learners, Instructional practices, Novice teachers, Teaching chemistry

1. Introduction

In recent years, teachers' workloads have been increasing in complexity. Society now expects them to deal with diverse students efficiently, respond to their needs accordingly, and be cognizant of evolving knowledge, technology, and approaches to benefit students' learning (Tolsdorf, Kousa, Markic, & Aksela, 2018). Consequently, teachers need sound knowledge, ability, and skills to make their teaching more inclusive in meeting the challenges in the present school climate. In improving students' learning, Watson, Beswick, and Brown (2005) stressed that teachers are connected with their content knowledge, pedagogical content knowledge, and "knowledge of students" as learners. To successfully target instruction towards students' distinctive learning needs, in particular, knowledge of individual students' abilities is highly required for a teacher. The notion is consistent with Shulman's (1987), who espoused that teachers must have a good grasp of diverse students regarding their abilities and interests and how they respond to various classroom circumstances. For a complex subject like chemistry, teachers must be familiar with methods that enable various levels of students to instantly engage and comprehend the subject's challenging nature (Boesdorfer, 2019).

Treagust, Nieswandt, and Duit (2018) argued that considering students 'starting point', which includes prior knowledge, students' conception, and ability, plays a significant contribution in planning and teaching chemistry. Likewise, Tolsdorf et al. (2018) highlighted that teaching chemistry classes with diverse students and trying to meet their learning needs requires the 'sensitisation' of teachers – the ability to respond to the learners' differences for their benefit during teaching and learning. In contrast, instructional practices which did not consider learners' ability and preferences will only impede the learning process (Redhana, Sudria, Suardana, Suja, & Handayani, 2018). With the interest of this issue in mind, the researchers set out to explore Malaysian chemistry trainee teachers' experiences (herein known as novice teachers) in teaching mixed-ability students during their practicum in school and particularly on their instructional strategies for dealing with those learners in the class. Even though novice teachers were exposed to necessary training, past studies highlighted several issues and their struggles while dealing with students in class. Among others, novice teachers are claimed to give less attention to student needs, struggle to cope with students' inability to understand the lessons, lack of ability to recognise significant learning circumstances, lack exposure to the classroom environment to practice instructional differentiation and opt for 'convenient' instructional approach which posed the least impact on learning (Al-Shaboul, Al-Azaizeh, & Al-Dosari, 2021; Ardisa, Wu, & Surjono, 2018; Redhana et al., 2018; Salleh, Nasir, & Ismail, 2020).

Therefore, from the researchers' point of view, delving into this study is essential as it allows the researchers to contribute to the literature and understanding of novice teachers' instructional practices within the scope of this study. Moreover, there is a scarcity of studies on instructional strategies among novice teachers in dealing with mixed-ability learners (Dack, 2019), especially for STEM subjects (Anna, Auerbach, & Andrews, 2018). Additionally, the few existing studies within the scope of this study only focused on the critical role of novice teachers' pedagogical knowledge and pedagogical content knowledge (Anna et al., 2018) and mostly on novice science teachers in developed countries (Boakye & Ampiah, 2017). Consequently, to have an in-depth understanding of the phenomena, the study set out to answer the research question; what are the instructional strategies adopted by Malaysian novice chemistry teachers in teaching mixed-ability students? The study findings would help the related stakeholders (e.g., teacher training institutions, Ministry of Education) devise strategies to continuously build teachers' capacity to provide quality education for mixed-ability learners.

2. Literature Review

2.1 Mixed-ability learners

In making lessons inclusive, the term mixed-ability classroom is becoming more common among teachers and scholars. For example, Nusrat (2017) defined a mixed-ability class as "comprising students of different ability levels". In other studies, mixed-ability students were depicted together with several other traits besides learning ability like characteristics, proficiency, motivations, educational backgrounds, learning styles, personalities, skills, interests, learning needs and learning preferences (Bekiryazıcı, 2015; Ramli et al., 2022; Syathroh, Musthafa, & Purnawarman, 2019). However, Saleh, Lazonder and Jong (2007) argued that, while teachers can draw on their ideas to differentiate students by ability, educational researchers generally utilise more objective criteria. For example, in most studies, the ability is measured relative to the student's academic performance, usually from an assessment relevant to the domain under study.

Academic performance is commonly associated with students' cognitive ability (Alves, Gomes, Martins, & Almeida, 2017) and is objectively used by teachers to differentiate students' ability though teachers frequently face immense combination traits in any given classroom (Markic & Abels, 2014). Along with this view, Mirani and Chunawala (2010), in their study, discussed works of literature that portrayed students' differences in class as low, moderate and high performing students or slow and quick learners based on their performance in a particular subject. In Freedberg, Bondie, Zusho and Allison (2019) and Yin, Lee and Zhang (2020), similar terms also have been adopted to represent students' variations in the classroom. Given the similarities and differences, this study uses students' academic performance, their skills (e.g. problem-solving, information processing), readiness and learning profile as the criteria to differentiate students' ability in class, which is in line with the work of Alves et al. (2017), Markic and Abels (2014) and Nusrat (2017) for the ease of discussion.

2.2 Strategies in teaching mixed-ability learners

Most classes contain mixed abilities learners. Hence, catering to the differences to reduce the performance gap and maximise their learning experience is central to teachers' instructional practice (Othman, Shahrill, Mundia, & Tan, 2016). In past studies, countless strategies could cater to mixed-ability students within a classroom environment. Among others, assessing pre-requisite knowledge (Markic & Abels, 2014), collaborative learning (Neo, Liu, Wang, Tan, & Low, 2014), flexible grouping (Duan, Shi, & Wang, 2020; Yin et al., 2020), assessment for learning (Chan, 2016), gamification (Israel, Wang, & Marino, 2016), integration of technology in learning (Mohamed, 2021) and adaptive teaching (Parsons et al., 2018). However, one commonality in the studies depicts how the researchers factored in learners' issues and the need to devise an intervention or informed instructional practices in class for the benefit of students. Similarly, past studies on inclusive teaching practice echoed, taking individual students' needs, preferences, interests or achievements into teaching consideration or practice of differentiated instruction were the two most claimed by past studies considered as providing inclusive learning to students.

For decades, differentiated instruction (DI) has received much interest from many educational practitioners as an approach that caters to mixed-ability students' needs (Smale-Jacobse, Meijer, Helms-Lorenz, & Maulana, 2019). The approach's philosophy believes that teaching and learning approaches must be a good match for students to provide them with the most significant opportunity to learn and progress (Al-Shaboul et al., 2021). By referring to the differentiated instruction framework by Tomlinson (2014), differentiation generally includes adjustment of instructional practices that cover the four aspects, namely content, process, product, and learning environment (Pereira, Tay, Maeda, & Gentry, 2019). The adjustment was the assessment results of students' readiness or other attributes like learning preference or interest (Tomlinson, 2014). However, other scholars argued that differentiation in diverse student differences could be approached differently (Corno, 2008). As such, the use of typical whole-group instruction followed by differentiation based on individual needs can be adopted (Parsons et al., 2018). The structure of DI embedded in the classroom also can be varied depending on the teacher's judgment (Smale-Jacobse et al., 2019); for instance, a teacher can either use a fixed or flexible macro-adaptation strategy based on students' common traits (Navrátilová, 2019) or micro-adaptation strategy (the continuous instructional practice in response to individual students) throughout teaching and learning (Parsons et al., 2018).

As DI by nature is a planned process through teacher's thorough consideration prior to its implementation, certain scholars contend that micro-adaptation is not considered part of differentiation in class (Coubergs, Struyven, Vanthournout, & Engels, 2017; Tomlinson, 2014). However, other scholars argued that differentiation should also be in 'real-time' and not only based on a careful instruction plan (Corno, 2008; Parsons et al., 2018). To a certain extent, the view is deemed as relevant as well-implemented DI is based on the continuous assessment of learning and flexible adaptations to cater to the students' needs (Deunk, Smale-Jacobse, de Boer, Doolaard, & Bosker, 2018). Therefore, in conducting this study, the researchers include the 'impromptu' teaching adjustments made by the teachers as part of their instructional strategies to deal with mixed-ability learners as it is deemed a relevant process of differentiation practices in class.

3. Methodology

3.1 Research Design, Site and Participants

This basic interpretive (Merriam, 2009) study is part of a larger study exploring the Malaysian novice chemistry teachers' experiences, particularly their instructional practices in teaching mixed-ability students during their teaching practicum at secondary schools for 14 weeks. The aim is in-line with choosing an interpretive study design to understand how people make sense of their experiences (Merriam, 2009). The participants of this study were comprised of twelve (12) novice teachers, five (5) males and seven (7) females. They are from the Bachelor of Science Education programme, majoring in Chemistry at one public university in Malaysia. Their age range was 23 – 27 years old. Purposive sampling was used to select the participants of the study. The sampling strategy lies in selecting participants whom the researcher can learn a great deal about issues of the inquiry. The main criterion for choosing these teachers is mainly based on their experience dealing with students of different abilities in their class. Most of the participants were assigned to teach at least two unstreamed chemistry classes in public schools in the state of Selangor, Malaysia. Additionally, they were also among the trainee teachers who could freely express their own experiences and opinions when audiotaped during their interview sessions with the researchers.

3.2 Data Collection and Analysis

The study began during the week of the post-practicum seminar, held after completing 14 weeks of the school's practicum. As the researchers did not have access to observe all the participants in schools, interviewing was deemed necessary as the primary data collection method (Merriam, 2009). Therefore, verbal data is the primary data source for this study which was gathered through semi-structured interviews. The interview structure allows the researchers to react to the participants' responses during the session, such as by probing for clarification of emerging responses given by the participants. The interview followed a set of interview protocols validated through peer review. Participants were provided with a consent form before conducting the interview for ethical consideration.

Data from the interviews were analysed using constant comparative method analysis. All audio records were transcribed verbatim. The transcriptions then were read several times for familiarisation purposes. The data from the transcripts then were chunked and coded. Patterns identified from the emerging codes then formed several main categories (Saldaña, 2013). This study's data collection and analysis were conducted concurrently and iteratively until the data saturation point was achieved. The researchers used peer examination, code-recode strategies, and an audit trail to ensure the trustworthiness of the study. For instance, the researchers initially grouped the emerged data into three main categories: strategies, adapting to the learners' needs, and frequent use of formative assessment. However, the third category emerged through peer examination to form a sub-category called assessment practice. The assessment aspect is viewed as part of the whole-class instructional strategies deemed suitable as a sub-category. The word strategies, used as the main category, also has been changed to a whole-class approach to better reflect the phenomenon.

4. Results and Discussion

The analysis found that novice teachers in this study view the differences among mixed-ability students based on four criteria. First, they see their students are different based on the grade of performance in tests or examinations, second their ability to grasp the delivered content, third, their ability to solve problems related to the topics and lastly, their readiness towards learning. The criteria they pointed out are the leading indicators used to differentiate their students in terms of their ability, whether they are excellent, moderate, or weak in a chemistry class. As this paper described the novice teachers' instructional strategies in dealing with those learners in teaching the chemistry subject, two main categories emerged from the data analysis process. They are the whole-class approach and adapting to the learners' needs. However, the paper will only discuss the first theme, the whole-class approach. The whole-class approach reflects the practice used by the participants at the whole-class level by applying a specific strategy to the entire class of mixed-ability students. Researchers found that this first-tier instruction was applied at the whole class level (macro-level) as the common practice used in lesson planning and execution. Three sub-themes depicted this approach: active learning activities, stimulating teaching materials, and assessment practice. The summary of the findings is depicted in Figure 1 below.

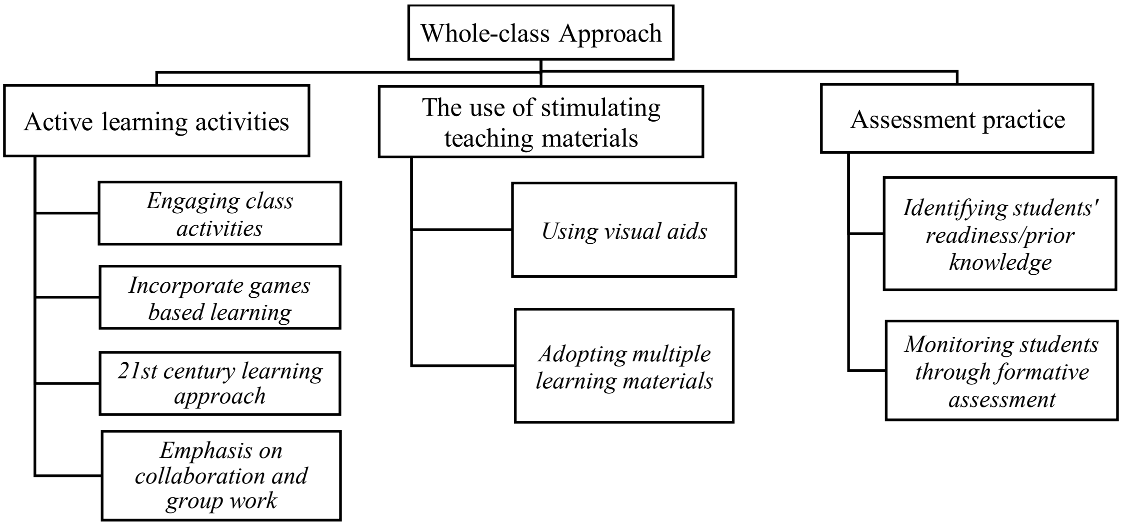

Fig. 1. Summary of the theme and sub-themes of the findings

4.1 Active learning activities

The first sub-theme of the whole class approach is active learning activities. When the participants were asked about their instructional strategies in teaching chemistry while dealing with mixed-ability learners, the frequent response was to get more students in the class to experience active learning. The teachers believe that participating in active learning activities will help students better understand the subject as they enjoy the learning process despite having different ability levels. The subsequent sub-headings describe this sub-theme in detail.

4.1.1 Engaging class activities

The majority of the teachers claimed that if they opted for a chemistry lesson that did not require students' participation much, it would cause the students to feel bored and less interested, thus, affecting their understanding of the lesson, especially the weak students. As a result, the teachers implemented various engaging class activities that students prefer and are excited to be involved with (e.g. producing lyrics, drawing, simple demonstration, analysing food labels), as concurred by Teachers B and F:

> Though students are different in terms of their performance or understanding of the subject, **I noticed they are always excited if I run activities in class that involve them**. It doesn't matter if I ask them to do a **simple demonstration, putting up cards of chemical elements on the whiteboard, identifying chemical substances from the food label**.….they prefer to do something in class, especially the weak students.. (B, ln. 57 – 60)

> I never miss the point in giving them to do the activities in the class besides just hearing me talking in front of the class. **The activities that I gave every week varied but mostly engaged them in my lesson**. There are times when I asked them to **write lyrics about chemical bonding and sing them in class or gave them a chance to show their state of matter model**

> **or drawing**. It was **indeed a great experience for students to learn in a fun way** (F, ln. 36 - 39)

Based on other teachers' responses, the researchers also found that the engaging activities that practised by some of the participants also meant 'assigning students to something' during class which includes other typical class activities (e.g., jotting down notes, filling in handouts, highlighting texts) (Teacher J, I and K) other than passively listening to teachers' explanation. Goss, Sonnemann, and Griffiths (2017) concurred that an engaging classroom is essential for effective teaching and learning. It also deepens students' learning and is proven by empirical studies as capable of improving students' behaviour and achievement in learning (Baker & Robinson, 2018; Goss et al., 2017). However, Salleh, Abdullah, Alias, and Ismail (2014) claimed that it is not just materials and activities that are vital in engaging learners but also teachers' roles in supporting and connecting the entire experience in bringing meaning to the lesson.

4.1.2 Incorporate game-based learning

Though the activities described by the participants were varied, the researchers found that game-based learning activities are one of the most frequent responses that can attract all learners in their classes. Furthermore, they asserted that by using game-based learning, various students in the class would be more interested to learn chemistry, cooperate more with instruction and have a better interaction in class, as depicted in the following excerpts by Teachers D, E and G:

> Usually, I will conduct **games and competitions** in class to **attract my students' attention**. Only then there will be **active interaction between students** in my class (Teacher D, ln. 72 - 74)

> I saw my students like to play games and **easily get excited even the game was simple, like guessing chemistry words or matching experiment procedures and the diagram on flashcards.** They also **easily remember** what they had learnt (Teacher E, ln. 48 - 51)

> The class usually **will give full cooperation whenever I conduct games** and activities. The entire class seems to learn in a fun way..like when I used the **mix and match blocks for elements in the periodic table or used puzzles of anions and cations to form chemical formulas.**.they definitely will participate more no matter they are weak, moderate or excellent in my class.. (Teacher G, ln. 121 - 124)

Concerning the use of games in the mixed-ability science classroom, past studies assert that using game-based learning in science classrooms significantly contributes to students' learning. The benefits to the learners with different learning abilities include better knowledge integration (Liu & Chen, 2013), improved learning experience, achievement and knowledge retention (Selvi & Çoşan, 2018). Besides, games also affected students' affective aspects, such as improved attention (Tan et al., 2018), enhancing their interest and motivation to learn science topics (Neo et al., 2014). Furthermore, Selvi and Çoşan (2018) asserted that the features of informative and entertaining games help reinforce students' learning and promote collaboration with peers in class. Studies on the use of games in DI lesson implementation have proven its' suitability to be incorporated in a mixed-ability class (Israel et al., 2016).

4.1.3 21st-century learning approach

Another recurring example of active learning activities extracted from the participants' responses was the implementation of the 21st-century learning approach. Those who implemented the approach gave similar remarks as teachers' who used games as they chose common 21st-century learning activities in class such as gallery walk, think pair and share, stand and share – to name a few to hold students' attention and get them to engage more in the lesson under teacher's facilitation or monitoring. For example:

> **My students enjoy all the 21st-century activities such as gallery walk, three stray one stay**...if I do this in class, they don't have to listen to my explanation all the time, and **generally more students will talk and** discuss though sometimes they talk about something unrelated…**, if they are not sure, they will easily ask their friends to re-explain**, that's what I like about it..but **I also need to call particular students to ensure they participate**.. (Teacher A, ln. 95 - 98)

> **Whenever I need students to pay attention or respond, I will use think-pair and share…students discuss, and then I will randomly call them** to share their ideas..it works for my class or else they will just take things for granted. (Teacher C, ln. 145 - 146)

> That's why I think my students enjoy the 21st-century activity; they can move around and make noise in class..but I'll make sure they will **complete the task** because I will ask to pick the students randomly and **share what they have learned afterwards** (Teacher I, ln. 74 - 77)

A study by Bray (2016), which practised 21st-century activity in class, revealed that this approach significantly enhanced students' engagement and conceptual knowledge. The result is in line with the responses given by teachers and justifies their strategy in class. Furthermore, Stehle & Peters-Burton (2019) concurred that students who participate in knowledge construction would better comprehend the content than their counterparts who did not. Likewise, through these kinds of activities, students will be provided with choices within their tasks, be able to set goals, self-evaluate their work and make progress which could enhance students' self-regulation (Freedberg et al., 2019). Therefore, implementing 21st-century classroom activities will undoubtedly benefit students despite their ability differences. Moreover, Ibrahim, Adzra'ai, Sueb and Dalim (2019) indicate that trainee teachers have a high level of readiness in conducting 21st-century class activities. Therefore, besides students' preference for the active learning activity, teacher readiness towards implementing the strategy could also be one reason for the practice.

4.1.4 Emphasis on collaboration and group work

Another recurring strategy in this theme is the emphasis on collaboration and group work among students in their class. Based on the majority of the participants, this kind of activity serves typically as a platform for students with different or similar ability levels to collaborate in order to complete an assigned task, as stated by Teachers F, H and J:

> Usually, in a one-hour class, I only used 20 minutes of lecturing, and the rest was for **them to brainstorm among their friends.** Students can **give opinions to their group members without being afraid of being judged** for right or wrong.. (Teacher F, ln. 42 - 43)

> I provided some time for them to understand problems related to a specific topic and asked them to **discuss the problems in groups**; the **good students can lead while the moderate and weak also can contribute what they know and learn from their peers** (Teacher H, ln. 61)

> I also did a **group work presentation** approach. For example, they need to **work together** and prepare an illustration of a topic and explain to others (Teacher J, ln. 151 - 152)

As the researcher inquired about the reasons for choosing group work, the teachers mainly emphasised the need for the students to work collaboratively with their peers in chemistry class and how the activity benefits the students in learning the subject (e.g. learning from one another, providing support to peers, solving task collaboratively). Besides what has been highlighted in the excerpts by Teacher F and H earlier, it also can be seen clearly in responses given by Teacher K (ln. 213 – 223):

> Researcher: Why did you ask students to discuss in the group in your class?

> Teacher K: I **encourage them to work in groups to ensure all students try their best in the task that I give** them…
> Researcher: What do you mean they can try their best?
> Teacher K: Hmmm...I believe **learning chemistry is not simple for most students**. Therefore, **within a small group**, all **students will feel that they have support** and probably **less worry as other students may also face the same problems they have**.
> Researcher: How did the situation help students to try their best?
> Teacher K: I think indirectly they learned that they had been provided with an **equal chance to solve the task**, they learned to **work together and see how other students would approach a specific problem that could be different from what they think** at the end of the day, they managed to solve the assigned task.

This study found that individual teachers also used flexible and heterogenous grouping strategies to ensure that students with different abilities could collaborate effectively to complete the assigned tasks in class. According to the teachers, excellent students in the group will help those moderate or weak students better understand the lesson or guide their friends with appropriate strategies to solve a specific problem (Teacher H, ln. 61). It also benefits excellent students by strengthening their knowledge and skills while assisting their peers in learning. The following excerpts by Teachers L and F depict this scenario:

> A strategy that I used was to **divide them into groups**. I will decide who is in that group and **change different students every week**. Actually, I want to **make sure that one group consist of students with different levels. Only then they will do the task I assigned to them.** For instance, when they were asked to conduct experiments or to do a simple presentation... (Teacher L, ln. 163 - 166)

> For me, that is more than a relief to see all of them **collaborate regardless of their academic performance**. S**tudents who understand more can teach and show their friends how to solve the task in class**. I remember I used this strategy a lot in topics that required students to do calculations for the number of moles, molar mass and when they learned about chemical formulae and equations (Teacher F, ln. 98 - 101)

Based on this finding, emphasising the collaboration between students in class through group work is one practice that can encourage students to work together, share their ideas and help each other out (Arthurs & Kreager, 2017). Tanner (2013) echoes that, for some students, participating in a whole-group discussion may be a persistently daunting experience. Therefore, allowing students to work in small groups will foster an inclusive community within a large classroom (Tanner, 2013). Additionally, Stehle and Peters-Burton (2019) asserted that working in a group will improve students' collaboration and communication skills while constructing knowledge and solving problems. It is very much in-line, as Mathias (2014) claims that small grouping activity improves student achievement as it allows them to make connections and build resources with their peers. Peer feedback during group activities also gives students the idea to revise their work (Stehle & Peters-Burton, 2019). Both higher and lower achievers will be benefited from a learning environment that is more cooperative rather than competing for them. Moreover, flexible and heterogenous grouping also is considered a good differentiation strategy to be used by teachers to cater to learners' differences in a class (Duan et al., 2020; Smale-Jacobse et al., 2019).

4.2 The use of stimulating teaching materials

In dealing with mixed-ability learners, the choice of teaching materials that support the activity also should be thoroughly considered. Therefore, a details description of the use of stimulating teaching materials is presented in the following.

4.2.1 Using visual aids

Some of the teachers mentioned that teaching materials play crucial roles by supplementing their choice of delivery or activities while confronting the demands of different learners in chemistry class. For instance, for teacher A, even though some of her students prefer to have a 'chalk and talk method, the execution of the approach cannot only be delivered in teacher-centred and one-way interaction – the way this method is commonly implemented. Instead, the 'chalk and talk' needs to be conveyed interactively with the incorporation of teaching aids to draw the interest and attention of various students in the class. It was also found that teachers commonly used visual aids as their teaching materials. Most teachers claimed that visual aids played important roles in teaching the subject. As emphasised by the participants, students need to 'see' to understand (Teacher D, ln. 45 – 46, Teacher A, ln. 147, Teacher B, ln. 156 – 57).

The most frequent example of visual aids identified from the responses was video, as it is a readily available source from a platform like YouTube that teachers can download and use in their class. Besides, most of the teachers considered that using video in teaching also is appealing to a broader student population in class. The animation and graphics in the video stimulate students' interest and make them more focused on the topic. Video is also deemed the best tool to visualise process, structure or concept as the teachers claimed that individual students struggled to imagine only by looking at the pictures on slides or textbooks. Also, the video provides ideas for students to inquire further or discuss the content presented in class. The following excerpts support the descriptions:

> Media is important to support learning. **Any source of media such as YouTube is used to aid learning**..video from YouTube can **attract students' attention despite their ability differences** if it is interesting…I showed them the animation of the electrolysis of water to help them **to understand how hydrogen and oxygen gases are produced at anode and cathode**..when they did the same experiment. T**hey already have an idea of what happened even though they can only see the final products of the process** (Teacher H, ln. 83 - 87)

> To be honest, I rarely use video, I only asked my students to look at pictures or diagrams, but starting from that week, **I included videos or animation from YouTube**, I think it **appealed more to my students** to listen to my explanation and **help them to visualise the process better, especially if it occurs at the microscopic level**, I also **asked about their opinion based on the videos, they responded well** as they can see what I'm talking about in class (Teacher J, ln. 137 - 141)

Besides video, another visual aid commonly used was a slides presentation. Slides presentation is perceived as suitable in class as it can be integrated with texts and other visual aids like pictures, diagrams, and videos. By providing a vast variance of visual representation to the students, the teachers claimed that it would help draw students' interest and attention to listen to teachers' explanations. In contrast, some teachers also highlighted the drawbacks of depending too much on slides in class. If the information like text, diagrams and videos presented to students were too much, they could quickly lose their focus or confuse some students (Teacher C, 181 – 184, Teacher E, ln. 87 – 91, Teacher G, ln. 133 – 135). Sometimes novice teachers also struggle to simplify the sentences extracted from the textbook or reference materials, resulting in difficulties for students to comprehend the content effectively, especially those considered moderate or weak (e.g., Teacher J, ln. 136 – 138, Teacher L, ln. 92 – 93).

Some teachers also admitted that they sometimes tend to lecture more and infrequently reach out to students whilst presenting the lesson using PowerPoint slides. Nonetheless, the teachers concurred that using slides can benefit teachers in terms of cost, time, and energy in preparing teaching materials and also the students as integrating pictures, diagrams, or even quizzes in the slides could help students imagine and remember the content better (e.g., Teacher B, ln. 112 – 116, Teacher D, ln. 187 – 190, Teacher G, ln. 163 – 166). Furthermore, visual aids could be very useful in making a topic interesting, and the combination of both visual and audio stimuli is particularly effective since the two most important senses are involved. In this study, the stimuli amalgamation also can be seen in the use of slides presentation by the teachers. Overall, the use of visual aids made information gaining easier and helped in making learning practice appealing (Ramli et al., 2022).

4.2.2 Adopting multiple learning materials

Even though most of the teachers used visual aids to engage with most learners, researchers found that most novice teachers agreed that the use of multiple teaching aids would benefit different kinds of students in their classes. For instance, Teachers A, C and F emphasised that students are also inclining toward different learning materials other than visual aids. Nevertheless, they acknowledged that students would mostly be provided with limited learning materials for specific lessons due to convenience or constraints faced by the teachers. In line with these findings, the researchers found that only a handful of teachers mentioned using other alternative aids like the model, tangible, or hands-on materials. They also asserted that materials could provide visualisation and kinesthetic experience to their students. For instance, as students observe, touch and manipulate the materials, they can engage more and learn meaningful experiences from the process. The examples are provided in the following excerpts:

> When I taught chemical bonding topic, I showed them the **atomic bonding model** while explaining the single, double, and triple bonds. After that, **they can play with the model and see how the bonding formed, they learn to manipulate the materials and, at the same time, learn how to draw the bond formation on paper** (Teacher B, ln. 48 - 50)

> Besides that, I asked students to **use plasticine to show the electrons sharing process**; they refer the diagram on paper and prepared the model themselves, **I asked them to do one example, but they ended up doing more** (Teacher H, ln. 66 - 67)

> To help students relate, I brought **household materials with labels** and asked them to **identify chemical compounds that they knew**. They **diligently work in groups and seemed excited** to me (Teacher I, ln. 119 -121)

Besides visual aids, incorporating concrete materials also benefit students by helping students to relate to the topic and providing hands-on activities that will emphasise the use of skills and knowledge (Maduna, 2002). It also allows teachers and students to engage in 'learning by doing' in chemistry while fostering their manipulative skills (van Driel & De Jong, 2015). It is also evident in another study that appropriate use of teaching aids would prompt the execution of the science concept and thus allow students to understand better. However, in teaching mixed-ability classes, past studies assert that teachers still struggle in choosing and presenting the appropriate teaching materials for their students (Nusrat, 2017; Ramli et al., 2022; Syathroh et al., 2019). Likewise, novice chemistry teachers who participated in the study by (Tolsdorf et al., 2018) experienced a struggle to consider the dimensions of diversity in preparing material suitable for more high-performing students. Teachers also reported the need to invest more time in making the teaching materials for their students (Tolsdorf et al., 2018) while confronting the demand for other academic and non-academic tasks (Ramli et al., 2022). Nusrat (2017) argued that due to different levels of motivations and abilities, some high achievers might think that certain materials are too easy for them and quickly become bored or low achievers may feel frustrated because certain materials are too hard for them.

4.3 Assessment practice

'Assessment practice' describes the teachers' strategies to differentiate students and gauge their learning attainment. It was a critical practice that the teachers used to determine the level of their students prior to and after they carried out the lesson. The following describes the sub-themes in more extensive.

4.3.1 Identifying students' readiness/prior knowledge

The researchers found that novice chemistry teachers frequently identified students' readiness or prior knowledge in class. Based on their responses, a pre-assessment is conducted to determine the extent of students' understanding of the previous topics or lessons pertinent to the new lesson that will be introduced to them. For example, according to Teachers F, D and E, identifying students' basic knowledge or skills helped the teachers gauge students' ability and readiness to learn a new topic (including sub-topics within the same chapter). They said:

> …before **I proceed with a new topic, I ask students to relate the past topic** with the new one **to test their basic knowledge**. Then I can guess who is ready to learn can understand the topic well (Teacher F, 183 - 185)

> I will always **randomly ask any students what do they know about the topic** that I am about to teach on that day..**usually, I will get various answers from my students, sometimes totally not related**; **if more students also struggle to answer my questions, that means I have to revisit the topic** (Teacher D, ln. 239 - 241)

> …before starting the class, I had **asked them to answer simple quizzes individually; usually, I asked them three to five questions to recall what they had learned** previously, **the results indicated their actual understanding** of a particular topic (Teacher E, 182 - 185)

The responses showed that this practice mainly was incorporated into most teachers' routines in class. Some teachers planned their pre-assessment questions and used students' scores to indicate students' performances. However, the majority of the novice teachers practice asking random or spontaneous questions to random or targeted students in class as part of their induction set (e.g. Teacher F, ln. 188 – 189, Teacher D, ln. 239 – 241, Teacher I, ln. 171 – 173). Some stated that the strategy did not reflect the overall students' understanding of the topic assessed most of the time. Sometimes they proceeded with the lesson under the impression that all students acquired the basics but only during the latter part of the lesson found that many of their students had problems (e.g. Teacher K, ln. 160 – 164, Teacher H, ln. 193 – 196). Most of them reported that they did experience the same issues several times with a different set of students in class. Nonetheless, the practice of asking random questions at the beginning of the lesson as means to recapitulate previous topics is deemed by many as convenient to pre-assess their students in class.

4.3.2 Monitoring students through formative assessment

Besides conducting pre-assessment, the study found that novice teachers monitored their students' progress via formative assessment at the whole-class level. They mentioned that formative assessment was usually embedded as part of the classroom activities they conducted in class, and hence, the same formative assessment was designed for all students regardless of their ability differences. In addition, the teachers noted that assessment is necessary to provide feedback for students and make teaching adjustments in helping individual students during the lesson. However, the researchers found that the assessment used mainly focused on getting students to answer the question as to the followings:

> …usually I will do a **written pop quiz before the lesson ends** to ensure I will be able **to identify their level of understanding**. Based on the result, **students will be able to know their level,** and I can determine whether the strategy that is used to help them is working or not (Teacher K, ln. 246 - 249)

> By giving them some tests like a **simple question to test their understanding** of the lesson learnt on that day. Based on their answers, **I gave them suggestions on how they can improve** on their mistakes (Teacher I, ln. 281 - 282)

> When many of them **cannot solve the practice questions in class**, I will either **repeat the concept to the entire class or explain it from group to group** (Teacher, C, ln. 201 – 203)

Based on the teachers' responses, the researcher also found that they rarely use data from students' performance in formative assessment to reflect their practice or devise differentiation strategies for their upcoming lessons. One evidence is the use of random questions for the pre-assessment routine that has been mentioned earlier. Other glaring examples are depicted in the following excerpts.

> I think my plan was direct, **I used methods or materials that I thought were suitable for the lesson or topic and engaged my students**. I know that **I will get various responses or different levels of acceptance from my students**, but based on my experience, **I just adjust my lesson if necessary,** during lesson…. (Teacher A, ln. 248 – 250)

> Most of the time, **students answer the questions in the handout**, I discussed the answer in class..I did not collect the handout or modules regularly and **rarely recorded their marks**. Sometimes I did, but **when I planned my lesson, I rarely factored in their performance in my previous class**.. (Teacher H, ln. 192 – 194)

> Lesson planning can be overwhelming for me, especially thinking that I have too excellent and extremely weak students in my class. I often **try and error**; sometimes, the strategy worked; sometimes, it didn't. **But I don't really design my class to accommodate the different levels of learners in my class, with one strategy for all, and I adjust according to how students respond in class** (Teacher J, ln. 261 – 265)

The data reported validates the common culture of conducting formative assessments to gauge students' understanding among teachers (Oyinloye & Imenda, 2019). Even though many teachers incorporate pre-assessment or formative assessment into their teaching, it is less common to find them to practice assessment systematically (OECD, 2005). Fastier and Mohamed (2015) discussed the tendency of teachers to have already habitual practices of assessment for learning inculcated in their instructions. However, they discovered that some formative assessment practices were incidental and ongoing in the classrooms, mainly done by experienced teachers. Likewise, this study found little evidence that the participants used the outcome from the assessment to plan the differentiation for a specific group of students for the upcoming lesson but, in contrast, it was done by the novice teachers. The data obtained from the assessment practice based mostly used to give 'real-time' respond to students need in class supporting what has be highlighted by Fastier and Mohamed (2015) but mostly employed in using a typical strategy that focused on 'question and answer' during class.

Nevertheless, not all participants in this study were aware of the need to conduct the continuous assessment in their class or even realised that they probably have done it on a lesson-to-lesson basis. As mentioned earlier in this paper, assessment is the crucial practice leading to the differentiation practice in class (Chan, 2016; Deunk et al., 2018; Smale-Jacobse et al., 2019). However, not all participants in this study were aware of the need to conduct the continuous assessment in their class or even realised that they probably have done it on a lesson-to-lesson basis. Though the novice teachers conducted a formative assessment, they mainly employed a typical strategy focused on 'question and answer' during class. According to Tomlinson (2014), formative assessment should be approached more fluid and organic, seamlessly with students' learning experience. Also, in an academically diverse class, she posited that assessment should be more context-specific and consider students' readiness, interests, and needs.

5. Conclusion

In exploring how Malaysian novice chemistry teachers confronted mixed-ability learners in class, the study uncovered the instructional strategies that they adopted in their classes. Albeit the study found that most of the teachers implement active learning strategies in the class, it was apparent that the teachers mainly engaged mixed-ability students through whole-class instruction in most of their lessons.

However, it was found that novice teachers emphasise aspects like active engagement and collaboration between peers in their classrooms. In choosing activities and teaching materials for the lesson, not all novice teachers consider students' interests and preferences; however, they generally choose activities or materials that engage students in the lesson, such as media and visual teaching tools like videos. Only a handful of participants incorporated concrete teaching materials in class though they felt the need to use multiple teaching materials to cater to students' ability levels and needs. Even though the interest and preferences of students were accounted for, the teachers did not closely monitor whether the materials and activities chose benefits or impeded the learning process of students with different ability levels. Nonetheless, pre and formative assessments have been practised and incorporated in teaching the mixed-ability students in chemistry class. The study concludes that the practice was not well planned and systematically conducted. There was also a lack of assessment strategies and authenticity implemented by the novice teachers as they mainly focused on pencil and paper-based assessments for various learners in their classes. The researchers inferred that there is a possibility that teachers mostly were not being utterly reflective as they seemed not fully utilising data from the formative assessment to inform their decision in general lesson planning or to differentiate instruction for their students.

As an implication for higher education institutions (HEI), specifically that producing future teachers, the institutions should continuously enhance trainee teachers' knowledge and skills in various aspects, including 'knowledge of the learners' to enable them to facilitate and assist learners more effectively in class. It can be done by incorporating trainee teachers' teaching experiences feedback in crafting designated training for them and improving the existing curriculum, which could better prepare future teachers to practice differentiated instruction in mixed-ability classrooms. The study also recommends that more studies be conducted to explore instructional strategies practised by educators in various science disciplines classrooms at various educational levels in catering to the needs of mixed-ability learners.

6. Co-Authors Contribution

The authors affirmed that there is no conflict of interest in this article. Author1 carried out the fieldwork, prepared the literature review and methodology, and overlooked the whole article's writeup. Author2 and Author3 carried out instrument and data validation processes, reviewed the results' interpretation, and contributed to article refinement. Author4 prepared the literature review and carried out data analysis.

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