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Evaluation of Differentiated Learning in Chemistry by Using the CIPP Evaluation Model

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Abstract: Differentiated learning is important in the world of education, because of the diversity of students' learning methods and students' different knowledge backgrounds. The aim of this research is that differentiated learning in chemistry material and the teaching and learning process can run effectively and efficiently. Differentiated learning can eliminate students' fear of material they don't like, especially chemistry. This research is qualitative research, to see the effectiveness of differentiated learning, the CIPP research model is used. This CIPP model includes context, input, process and product, so it is said to be more comprehensive than other evaluation models. The research data sources are Chemistry Teachers, curriculum representatives, and students at three high schools in Jakarta. Primary data was collected using observation instruments while secondary data was obtained through questionnaires and interviews. The research results show that what happens in the field is that not all teachers apply differentiated learning during the teaching and learning process in the classroom. Through differentiated learning, students tend to be more active and enthusiastic about learning because classroom learning is carried out according to each student's interests, readiness, and learning style. So, learning activities with a differentiation system are stated to be quite effective.

Keywords: Chemical material; CIPP evaluation model; Differentiated learning; Independent curriculum

Introduction

Differentiated learning is a means of teaching all children to help them achieve a common goal, regardless of the path they take to get there. Since Tomlinson (1999) introduced and defined differentiated instruction, many others have created their own definitions. Instruction is distinguished as a deliberate and conscious method of planning and teaching that provides multiple learning paths toward clear goals. Wilson (2009) concluded there are two differentiated definitions of instruction: progression from simple tasks to complex tasks, and differences between individuals who are otherwise similar in certain respects, such as age or grade. In addition, "Differentiated learning is a planning approach so that one lesson can be taught to the whole class while meeting the individual needs of each child. Each of these definitions encompasses the importance of reaching all children with respect to their many differences.

Differentiated learning is based on the concept that the teacher is a facilitator of information, while students take a leading role in expanding their knowledge through research. Carter (2009) explains that the concept of constructivism is that students create their own knowledge and does not have to be learned through other individuals or sources. Powell et al. (2009) show that students thrive in enabling group project choice, this allows them to express their own personality. Students' express needs Class content becomes hands-on and meaningful. Additionally, students expressed interest in working with their peers, rather than completing worksheets individually. Best practice shows students thrive in an environment where educators use collaboration and authentic assignments (Gonzales et al., 2023).

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Differentiated learning can be most productive by using "an eclectic mix of methods combined with tact, logic, a good knowledge of educational psychology, and the art of experience" (Orlich et al., 2004). An eclectic approach allows teachers to consider a variety of sources and choose the ones that best suit their students. However, as Brown (2015) note, eclecticism may have little impact because mixed methods may appear more complex for students to understand and "if not carefully considered, articulated, and evaluated, the 'connecting science' that so many people work to create might be seen as a change to less rigorous activities.

Matching teaching styles with learning styles only avoids students' weaknesses, thus these weaknesses cannot be identified and can grow weaker. Fourth, several well-conducted research studies have provided evidence and positive results for learning styles. They have not been scientifically proven to exist so far. Findings in research studies also add to the lack of existence of learning styles. A research study conducted by Pashler et al. (2008) found no evidence to support the fact that students who received instruction tailored to their preferences outperformed those who did not receive customized instruction. These researchers found that providing different groups of students with different forms of instruction according to their interests did not maximize their performance on a single test. Likewise, other research further supports the evidence that there is no significant interaction between learning style and instructional version (Cook et al., 2007; Hsieh et al., 2009). In other words, different types of instruction do not produce effective results with different learners.

Because students are culturally and academically diverse, differentiated instruction should facilitate learning through the increased collaboration for students to exchange cultural and social values within a learning community support (Nordlund, 2003). In addition, students should be given the opportunity to explore new knowledge and develop a critical understanding of the subject matter through independent study. By focusing on collaboration and autonomy, differentiated instruction can accommodate a variety of students who are at a low level and need intensive support or at a high level and need their skills honed. Brown (2015) recommend that effective instruction should develop students' cognitive thinking and offer them opportunities to explore critically and "focus on the concept to be learned rather than the steps involved in completing a particular task." Additionally, teachers can reinforce successful student learning by asking if/then questions (e.g., If we wanted students to perform this way, then they need to learn this skill) to visualize the results and develop the sequence.

In recent years, the number of students choosing to study chemistry at university has decreased substantially (Bennett et al., 2005; Gilbert, 2006; Schwartz, 2006). However, several attempts at context-based approaches have gradually changed the downward trend to upward. But some problems facing chemistry education still exist: the chemistry curriculum is too dense in content (Gilbert, 2006; Pilot et al., 2006b), a weak connection between real life and scientific knowledge (Demircioğlu et al., 2009; Gilbert, 2006; Stolk et al., 2009b), students' difficulties in transferring chemical knowledge to different contexts (Gilbert, 2006), failure to see the reason for studying chemistry (Gilbert, 2006; Demircioglu et al., 2009; Stolk et al., 2009), a chemistry curriculum that is isolated from society and learners (Stolk et al., 2009a), passive involvement of students in the learning process (Stolk et al., 2009), failure to instill scientific literacy among students who will not continue studying the subject (Gilbert, 2006), and traditional chemistry education that emphasizes memorization of facts, theories, and rules (Stolk et al., 2009).

In traditional chemistry learning, the teacher writes on the blackboard, students listen, remember facts or rules, and answer when asked (briefly, chalk, and talk). Such learning can be seen as a ladder with too many rungs that students must climb (overloaded curriculum). But students often don't know why they are climbing the stairs, and fail to see the connections between adjacent steps. Moreover, traditional chemistry education is quite resistant to reform. However, content (subject knowledge) should be selected on a 'need-to-know' basis to develop a coherent mental map of chemical knowledge and to increase the relevance of the subject (Pilot et al., 2006a).

In these innovative projects, students not only have the opportunity to analyze events they encounter in everyday life but also become more aware of the relationship between chemistry and their everyday lives. Students can thus become more actively involved in their own learning process (Stolk et al., 2009). In these projects, the context that is the starting point for the development of scientific understanding (Bennett et al., 2005) is introduced to students to arouse their curiosity (Stolk et al., 2009). Students are asked to induce meaning using context thus, they justify a 'need-to-know' approach to content. Once students feel the importance and relevance of the material, their enthusiasm for chemistry increases (Barker et al., 2000; Potter et al., 2006).

Chemistry lessons are part of science or natural sciences which include many chemical concepts and require students to better understand these concepts, but in reality, in studying chemical concepts students tend to memorize without understanding their meaning, meanwhile the development of chemical concepts is

increasing, so that in ultimately causing students boredom and difficulties in studying chemistry.

Evaluation is a process of providing information that can be used as a consideration for determining prices and services from the objectives achieved, design, implementation, and impact to help make decisions, help account for, and increase understanding of phenomena. So, from this explanation, it can be interpreted that evaluation is a provider of information for consideration in making decisions and increasing understanding of a phenomenon. This is the definition according to Madaus et al. (1983).

According to Warju (2016), they state that measurement and evaluation assessments are hierarchical. Evaluation is preceded by assessment, while assessment is preceded by measurement. Measurement is defined as the activity of comparing observation results with criteria, assessment is the activity of interpreting and describing measurement results, and evaluation is determining values or behavioral implications.

In the field of education, in terms of targets/evaluations, some are macro and some are micro. The target of macro evaluation is educational programs, namely programs planned to improve the educational sector. Micro evaluation is a classroom learning program and the person responsible is a school teacher or lecturer at a university. Teachers have the responsibility to prepare and implement learning programs in the classroom, while school leaders are responsible for evaluating learning programs prepared and implemented by teachers.

If students lack interest in the subjects taught in school, they will have little motivation to learn. Emphasizing student interest involves knowing students well and teaching according to what motivates them. When students develop good feelings about their work because they enjoy it, and teachers combine activities that interest students with a nurturing environment, students tend to respond positively (Ellis, 2010). Teachers can emphasize student interest by allowing time for students to participate in independent study, a method of teaching that allows students to study what they are especially interested in. Another strategy is to show students how a subject matter relates to a topic in which students are interested.

In 1965 the United States passed the American Elementary and Secondary Education Act (ESEA). The Federal Government requires that plans subsidized by the ESEA (Elementary and Secondary Education Act) must use the Context, Input, Process and Product (CIPP) assessment method. CIPP stands for evaluation: Context, Input, Process, and Product. Context evaluation is used to select objectives. Input evaluation is used to revise the plan. Process evaluation is used to guide plan implementation. Product evaluation is used to provide a suitability assessment of the magnitude of the influence on variables (G. F. Madaus et al., 1983; Nicholson, 2014).

Method

The aim of this research is to determine and evaluate differentiated learning in chemical material using the CIPP (context, input, process, product) evaluation model in independent schools at three senior high schools in Jakarta (SMAN 53 Jakarta, SMAN 30 Jakarta, and SMAN 14 Kota Bekasi). This research will be carried out at four SMAN schools in Jakarta in the even semester of the 2023/2024 academic year.

The research method used in this research is evaluation research with the Context, Input, Process, Product (CIPP) evaluation model. Evaluation is a decision-making process using information obtained through measurement using information obtained through measuring learning outcomes, both using test and non-test instruments. So, the evaluation research method is a research method for making decisions from information that has been obtained through measuring learning outcomes or learning programs.

This research is aimed at evaluating differentiated learning in chemistry material using the CIPP evaluation model in the independent curriculum at three senior high schools in Jakarta (SMAN 53 Jakarta, SMAN 30 Jakarta, and SMAN 14 Kota Bekasi).

This research is divided into 3 stages including the research preparation stage, implementation stage, and final research stage. The following is a description of each stage:

Research Preparation

The initial research activity stage is the first stage that researchers must carry out in research. This stage includes needs analysis, making observation sheets, and questionnaires (in the form of a Google form), and making interview guidelines.

Making Observation Sheets

Making observation sheets aims to observe the conditions that occur during the research process. However, during the research, the researcher did not carry out the observation process on differentiated learning. Observations were made based on interviews conducted with research subjects.

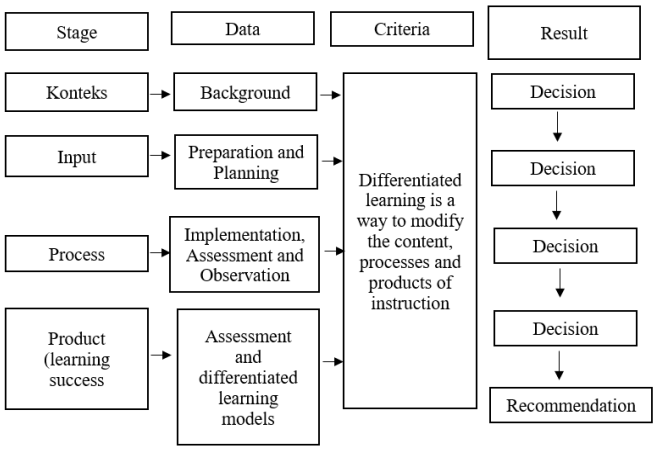

Figure 1. Research design for evaluation of differentiated learning

Making Questionnaires

The purpose of making the questionnaire is to find information regarding the evaluation of differentiated learning, especially in Class learning success (evaluation carried out to determine students' assessments of differentiated learning and decide on appropriate learning models during differentiated learning, especially in Class X chemistry lessons).

Making Interview Guidelines

Depth interview guide (in-dept-interview) was created as a reference in conducting interviews. The interview guide created refers to the CIPP (Context, Input, Process, Product) evaluation model. Interviews were conducted with the Head of Curriculum regarding the evaluation of differentiated learning, then with Class

Research Implementation

The implementation phase of this research focused on in-depth interviews with the deputy heads of the curriculum at three SMAN schools in Jakarta (SMAN 53 Jakarta, SMAN 30 Jakarta, and SMAN 14 Kota Bekasi), Class X chemistry teachers and students at three SMAN schools in Jakarta regarding the process, constraints, obstacles, and assessments in chemistry learning during differentiated learning. The following is a research implementation scheme which can be seen in Figure 2.

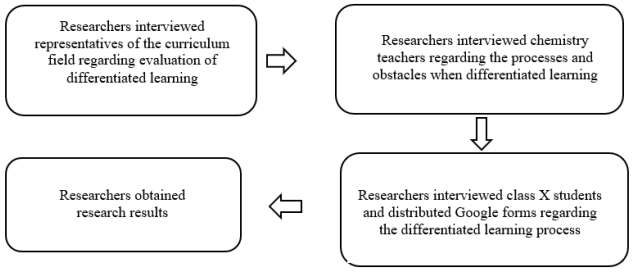

Figure 2. Research scheme

Final Stage of Research

In the final stage, the researcher collects the interview results and the questionnaire results are processed into a conclusion.

Result and Discussion

This research was conducted with the aim of finding out the effect of a differentiated teaching approach in Class X chemistry lessons using the CIPP evaluation model. Many teachers often ignore the talents of the most creative individuals, leading these individuals to unpleasant experiences similar to those experienced by Steve in class. Keefe (2007) discusses how some of the most talented people in the world, including Charles Darwin, Patrick Henry, Sir Isaac Newton, Louis Pasteur, Madame Curie, Orville Wright, Albert Einstein, and Marlon Brando, were encouraged to leave school as a result of their alleged inability to learn. Had their teachers respected the idea that different students learn in different ways and had they differentiated instruction according to their student's needs and talents, they might have recognized these students as gifted.

Differentiated learning is a way of recognizing and teaching according to students' different talents and learning styles. In the vignette mentioned above, a good strategy that Mr. Jones could have used would be to differentiate math instruction in a way that engages Steve and prevents him from daydreaming or misbehaving. This form of instruction is designed to meet the needs of diverse learners and emphasizes student responsibility, peer tutoring, flexible grouping, and student choice (Grimes et al., 2009). More importantly, this approach involves modifying instruction so that all students can be successful (Tobin et al., 2008).

This differentiated learning evaluation research on chemical material using the CIPP (Context, Input, Process, Product) evaluation model was carried out at SMAN 53 Jakarta, SMAN 30 Jakarta and SMAN 14 Bekasi. This research focuses more on chemistry teachers and Class X only. Apart from that, this research uses a descriptive qualitative approach and collects data through interviews, observation, and filling out questionnaires.

When observing in class, learning takes place conditionally. This is due to the motivation of teachers or teaching staff during the learning process and also because the learning process is carried out according to the interests and pleasures of each student so that they learn very enthusiastically. So that the learning results are more satisfying than when learning is carried out in a non-differentiated/ordinary learning manner. Because apart from being able to understand the material

presented more quickly, teachers also always ask questions that encourage students to think critically and be more active.

The concept of independent learning in implementing the independent curriculum focuses more on students' abilities and potential in building and developing their thinking. Meanwhile, the role of an educator is as a guide, mentor, and facilitator in achieving educational goals. Therefore, there is a need to change the mindset from the teacher-teaching paradigm (behavioristic) to the student-learning paradigm (constructivist).

The results of the research are an effort to answer the sub-focus of the problem so that we can find out the results of differentiated learning evaluations in chemistry material, especially at three high schools in Jakarta. Hopefully, the results of this research can provide benefits, suggestions, and recommendations or solutions for better differentiated learning, especially in chemistry. Research data collection was carried out in several stages, namely the first through interviews with curriculum representatives, chemistry teachers, and students of SMA N Class during differentiated learning.

In the research that the researchers studied, they focused more on the independent curriculum, learning styles, and interests of each student. Then, from the results of interviews with chemistry teachers at the three high schools, for auditory students the teacher provides sound recordings, for visual ones the teacher provides facilities other than sound recordings, there are also videos for illustration, then for kinesthetic students, they directly make a tool according to their wishes. Respectively, but the teacher still directs the steps to make it first.

Context Evaluation

In the book on educational assessment and evaluation by Yusuf, A. Muri, context assessment and evaluation is interpreted as needs assessment, because context assessment and evaluation is prepared to answer the question, "What needs to be done?" (Yusuf, 2015). Context evaluation is concerned with whether the curriculum includes the focus, goals, and objectives of the curriculum, meaning organizational parameters. It also assesses the environment in which the evaluation takes place. Aggregate data and information collected serve as the basis for curriculum decisions and subsequent development of objectives. Therefore, context evaluation includes: policy, surrounding environment, and needs assessment, at the very least.

Based on the regulations of the education office (Permendikbud), differentiated learning has been carried out in several schools at SMAN in Jakarta, especially at SMAN 53 Jakarta, SMAN 30 Jakarta, and SMAN 14 Bekasi according to what researchers have researched. So, the policies given by the teacher are based on the rules given by the school and through the IHT (In-House Training) activity process as the teacher applies these rules.

So, the first step as a curriculum representative is: during an interview with the curriculum representative of SMAN 53 Jakarta (Ms. MT) on Thursday, June 8, 2023, she said:

> "The first thing the curriculum sector must do is always emphasize following the new regulations from the education department that all teachers must implement differentiated learning which is currently trending. "Usually, through in-house training or every time there are meetings, we are always reminded to follow the new rules from the education department, namely that we must use differentiated learning or learning that is carried out according to the interests and pleasures of each student."

According to Mrs. R. as the representative for the curriculum at SMAN 30 Jakarta:

> "He said that when the nuances of the independent curriculum have to be implemented in schools, schools must also implement the regulations from the education office. However, before implementing the rules, the school must first fill out a questionnaire from the Permendikbud regarding how prepared SMAN 30 Jakarta is to implement the rules from the education office regarding differentiated learning. "But as a management team, before the independent curriculum was implemented, we initially provided nuances regarding this independent curriculum to the teachers so that they could change the teachers' mindset and when the independent curriculum had to be implemented, the team of teachers would no longer be surprised because they had previously been given directions." In accordance with the regulations from Kepmendikbudristek Number 262/M/2022 concerning amendments to Kepmendikbudristek Number 56/M/2022 concerning "Guidelines for Implementing Curriculum in the Context of Learning Recovery, which was then called the Independent Curriculum".
>
> (Interview with a representative of the curriculum sector at SMAN 30 Jakarta, August 7, 2023).

According to Mrs. H. as the representative for the curriculum at SMAN 14 Bekasi:

> "The first step as a representative of the curriculum sector is usually when the teachers are gathering or during a briefing or at a meeting, the curriculum sector always makes an effort to always apply this differentiated learning, because this is a new rule and this year there is a lot of buzz regarding differentiated learning. Even though only 50% of teachers have just implemented it, the curriculum

always reminds all teachers about the application of differentiated learning in the classroom."

(Interview with the representative of the curriculum sector at SMAN 14 Bekasi, August 8, 2023).

Although differentiated instruction is designed to benefit all students, it requires extraordinary hard work by knowledgeable and well-prepared teachers. Using this teaching approach effectively will definitely help teachers learn and lead all students to do their best work. This teaching strategy could be the most important trend for a better future for the education system. So from this context evaluation it can be concluded that the school implements a learning system in accordance with what the government recommends. In making annual programs and semester programs, the school always discusses and reminds them through In House Training. Where the aim of implementing differentiated learning is so that students learn efficiently and effectively because learning is carried out according to the interests of each student. Apart from that, the first step a teacher takes is to plan first by paying attention to the learning style of each student.

Input Evaluation

Input evaluation includes analysis of the use of available resources, use of alternative strategies to achieve a program, system capabilities, procedure design for implementation strategies, financing and scheduling. Input evaluation involves examining the intended content of instruction (i.e. the skills or strategies students learn), and it is concerned with determining the resources and strategies used to achieve curriculum goals and objectives. Additionally, the input evaluation objectives should support resource selection. Therefore, input evaluation should include work plans, equipment, funds, and personnel resources at a minimum. This item is used to revise the curriculum plan.

Before carrying out learning, a teacher or educational staff must definitely create a learning module first or make a plan in advance by paying attention to the learning style and interests of each student so that the learning is directed. In the process of making learning modules, Mrs. Y. as a chemistry teacher at SMAN 53 Jakarta encountered a few difficulties because the learning modules had to be adapted to what conditions in the field were like. During differentiated learning, each teacher certainly has their own creativity to make the classroom atmosphere the way the teacher wants it or not bored and boring. So that from this input the teacher is ready to provide material according to the student's level of readiness according to the auditory, visual and kinesthetic groups. Each chemistry teacher in the three schools that the researchers studied had their own approach or method during the teaching and learning process in class. When I conducted an interview with Mrs. Y. as a chemistry teacher at SMAN 53 Jakarta where she said that:

"When you first enter class, you usually do conditioning by providing motivation or short questions and answers, but you haven't entered the material yet to see how ready the students are to learn before receiving the initial material."(Interview with chemistry teacher at SMAN 53 Jakarta, 8 June 2023). According to Mr. R. as a chemistry teacher at SMAN 30 Jakarta: "The usual thing to do when you first enter class is to do a pretest, which aims to find out the students' initial abilities so that later we can use treatment according to each student's abilities."(Interview with chemistry teacher at SMAN 30 Jakarta, 7 August 2023).

According to Mrs. F. as a teacher at SMAN 14 Bekasi: "When you enter class, you usually do initial conditioning with a short quiz regarding the material that will be presented at that time via Google Form. This aims to determine the level of readiness of students to learn new material."(Interview with chemistry teacher at SMAN 14 Bekasi, 8 August 2023).

Apart from that, according to Mrs. Where the role of a teacher is as a facilitator for students to encourage them to explore their world, reflect, discover knowledge, and think critically, not just convey information. Teachers build (to construct) students' thinking and understanding so that it is in line with the constructivist view. Differentiated instruction is based on Howard Gardner's theory that students learn through multiple intelligences (Kapusnick et al., 2001). Gardner (1983) first identified the following intelligences in his book Frames of Mind: logical/mathematical, verbal/linguistic, musical, visual/spatial, physical/kinesthetic, interpersonal, and intrapersonal. He later added a naturalist wit (Checkley, 1997). Teachers teach students who have difficulty grasping concepts in a way that allows students to understand the concepts and proceed at their own pace (Kapusnick et al., 2001).

This result can be achieved through several strategies. The first method that teachers can apply is the theory of multiple intelligences. Because students learn in different ways, teachers need to vary their teaching approaches to use the learning style that best suits a particular student. Other methods include providing more scaffolding for students who lack basic skills and challenging students above grade level to teach according to the zone of proximal development. An important strategy for differentiating teaching in the twenty-first century that is likely to greatly benefit students involves the effective implementation of technology (LeDune et al., 2023). Additionally, digital resources can easily be used to provide support for struggling learners and offer ways for them to learn

through a variety of formats that suit auditory, kinesthetic, and visual learning styles. Brain research supports the notion that digital natives are more stimulated through digital resources than materials in print format (Prensky, 2001).

Differentiated learning, Mrs., because sometimes Mrs. Meanwhile, Google Form is usually used for quizzes or short questions at the beginning before learning begins or enters the initial material. Meanwhile, Mr. R., as a chemistry teacher at SMAN 30 Jakarta, usually uses a visual platform, he often uses YouTube so that students can easily see pictures or illustrations of the material being studied, virtual labs, and PowerPoint.

Context evaluation, teachers have different learning strategies for each learning material. Mrs. Because after every lesson, Mrs. Meanwhile, Mr. R., as the chemistry teacher at SMAN 30 Jakarta, only asks questions to encourage students to start learning to think critically. He gave an example when the material was about nanotechnology and the questions asked were, for example, "Did you know that we in Indonesia look at spices as something that seems cheap, even though if it has been converted into a nano form, the price could be worth 10 to 20 times more?" so that from these questions Mr R. can conclude the level of students' understanding of the material being explained.

Process Evaluation

Process evaluation is carried out to see whether the program implementation is in accordance with the established strategy. Process evaluation is related to the implementation of teaching. Based on the results of trials or evaluations, process evaluation needs to describe student needs to reconstruct the program. The objectives are as follows: predict design errors; to provide information for decisions; and to ensure plan procedures. By using process evaluation, you can provide regular feedback to the program director. Researchers can understand the initial plan, discover the process, track changes to the plan, and provide materials to ensure its efficiency and achievement. Finally, the ways to collect process evaluation data are many. This includes the use of teacher behavior measures, teacher rating measures, standardized achievement measures, and expert reference measures.

The teaching and learning process in chemistry material at SMAN 53 Jakarta, SMAN 30 Jakarta, and SMAN 14 Bekasi has used a differentiated learning system, this is proven apart from interviews with the teachers concerned, it is also proven through questionnaire answers from students at SMAN 53 Jakarta. When researchers interviewed students at SMAN 53 Jakarta, they all answered in unison that learning chemistry material used a differentiated system. During an interview with Class X students:

Researcher: What do you think about the application of learning.
Differentiate especially in chemical matter?

Student 1: Differentiated learning in chemical material can be understood by good because with the differentiation method, I can also enjoy it more study chemistry. (Interview of a female student at SMAN 53 Jakarta, 8 June 2023).

Student 2: I am able to understand the lesson, even though it is a little difficult. (SMAN 30 Jakarta student interview, 7 August 2023).

Student 3: The lesson is very easy to understand because the material that was explained was very good. (SMAN 14 Bekasi student interview, August 8, 2023).

The results of the interview above show that with the application of differentiated learning, students find it easy to understand learning, especially in chemistry material, which is actually rarely liked by certain students. However, because learning is made according to the interests and readiness of each student, students do not feel too burdened during the learning process and receive the material presented.

Table 1. Results of the Differentiated Learning Process Questionnaire in Class X SMAN 53 Jakarta

The chemistry learning method in Class X uses a differentiated learning system.
The learning was normal because I had difficulty understanding it.
Learning is fun, because chemistry is one of the subjects that I am interested in, the way the teacher teaches is also a factor in my interest in paying attention to the lesson.
Learning is fun, because we can discover new things.
Learning is fun, because we can learn new things.

Table 2. Results of the Differentiated Learning Process Questionnaire in Class X SMAN 30 Jakarta

Learning is fun because you can know and understand the material together.
Learning becomes fun, because there is more variety in learning.
The learning is very fun. Projects in chemistry learning can make the material more interactive and practical. Through projects, you can experience chemical concepts directly, explore deeper understanding, and develop creativity in more interesting ways.
Learning is very fun because it frees students to express their ideas. As well as fostering a creative and innovative spirit from a young age.
Differentiated learning in chemistry learning means we can learn many projects through practical and interesting practices. Which can develop creativity, explore deeper knowledge, and understand the concepts contained in chemistry.

Table 3. Results of the Differentiated Learning Process Questionnaire in Class X SMAN 14 Bekasi

The learning is normal, because it is the same as other subjects.
Learning is fun, because there is more variety in learning, especially during chemistry lessons.
Learning chemistry can make the material more interactive and practical.
The learning is normal, but sometimes unclear.
We can develop creativity in a more interesting way so that we are more enthusiastic about learning.

From the results of the questionnaire above, it can be concluded that all students really like differentiated learning, because with this learning everyone can understand the material presented by their teacher, especially chemistry. Apart from that, students also feel motivated by differentiated learning because learning is tailored to the interests or preferences of each student at SMAN 53 Jakarta, SMAN 30 Jakarta and SMAN 14 Bekasi.

The description above is the same as that explained by Jalaluddin (2012), where creativity can only be achieved by students if they are given space and opportunities to develop their own independence and potential, which can be done by providing students with opportunities for individual learning/group; provide students with opportunities to learn through experience; provide motivation; involving students in every aspect of activities that constitute children's basic needs; and make students aware that life is dynamic. One type of learning that accommodates student creativity is differentiated learning.

Using multiple intelligences when providing instruction, rather than just one or two, is important because different students learn in different ways and through multiple intelligences. Students usually rely on their strongest intelligence when completing a task (Silver et al., 2000). Consequently, when teachers allow students to solve problems using intelligence that students prefer, they provide scaffolding and create more opportunities for their students to succeed.

Mr. Jones should teach in a way that allows his students to learn through other intelligences and observe whether Steve improves academically. This approach will likely make him more successful with Steve and others in the class. For example, in addition to his current teaching methods, he could assign his class to work cooperatively and place Steve in a group with other students who are more advanced in mathematics. By doing this, Mr. Jones will use interpersonal intelligence, thereby requiring student-to-student communication. It could be that Steve didn't understand the content well when Mr. Jones taught but finds it easier to understand the subject when working with peers because of their more familiar communication style.

Ellis (2010) explains that when students help each other, from greater syntactic compatibility, there is often more understanding from their peers than from adults. Another possible teaching option Mr. What Jones tried was to use manipulatives, such as small boxes, and assign Steve, and other students who were having difficulty, to use the boxes to calculate the math problems the class was working on. For example, if the class is working on a concept involving geometry, Mr. Jones could give Steve a box to calculate geometry problems, such as finding the area or perimeter of each side. It will likely help Steve if he learns best through hands-on activities. After experimenting with different teaching styles to find Steve's preferred way of learning, Mr. Jones will be in a much better position to help him. Differentiated instruction is also based on Lev Vygotsky's concept of the zone of proximal development and benefits learners at all levels to work at appropriate levels. Vygotsky's zone of proximal development is the level at which a student can perform tasks with the guidance of adults or more capable peers (Vygotsky, 19787).

The following are the results of filling out a questionnaire on barriers during differentiated learning for students at SMAN 53 Jakarta, SMAN 30 Jakarta and SMAN 14 Bekasi City Class X can be seen in Figure 3.

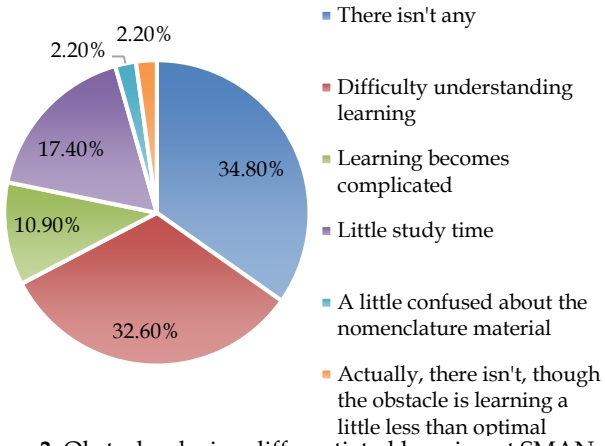

Figure 3. Obstacles during differentiated learning at SMAN 53 Jakarta

The diagram above shows that 34.8% of students from four classes answered that there were no obstacles during differentiated learning and 32.6% of students from four classes answered that it was difficult to understand the learning and after interviews it turned out that most of those who answered had difficulty understanding learning because they are afraid to ask questions and feel that the teacher's explanation is too fast. There were also 17.4% who felt that there was little

learning time and when confirmed through an interview with their chemistry teacher this was corrected because there was a lot of material so there was little learning time for each material and that was also one of the reasons why the teacher explained quite a bit fast. This is what makes it a bit difficult for some students who have poor comprehension skills to participate in differentiated learning, especially in chemistry material.

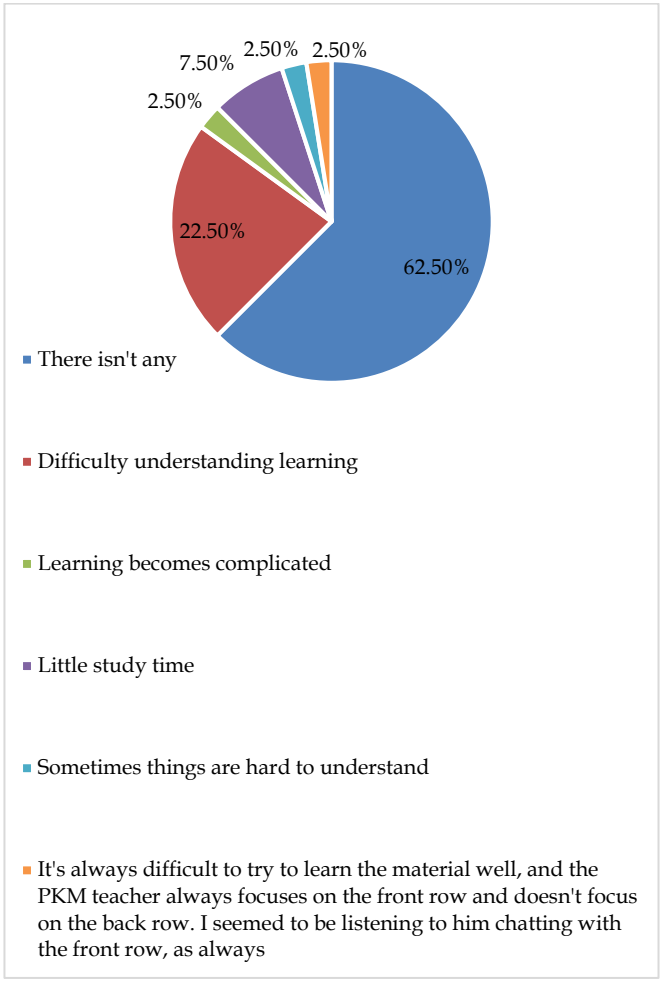

Figure 4. Obstacles during differentiated learning at SMAN 30 Jakarta

It can be seen in the picture above that from four classes of students at SMAN 30 Jakarta, 22.5% answered that it was difficult to understand the lesson, this was because they felt that, like other subjects, they could not listen to the teacher's instructions. Apart from that, this differentiated learning system is also new or has not been implemented for long so students are still adapting to the learning system even though the learning has been carried out according to the interests and readiness of each student. Meanwhile, 62.5% of students answered that there were no obstacles because they felt happy and did not feel burdened when studying, so they studied enthusiastically, although less compared to those who were not enthusiastic because it was difficult to understand the learning, but they were still enthusiastic about learning. And 13% of students answered that there was little study time, this was in accordance with constraints in the field, namely little time but quite a lot of material that had to be covered. That is also a factor that becomes an obstacle that makes it difficult to understand learning more compared to students who easily understand learning. Because they think that one material has not been studied completely and it is not clear that they have to move to another material. Today's students tend to be more engaged when using technology and may find traditional approaches less motivating, teaching effectively with digital resources will help teachers teach in a way that suits their students' learning styles.

If students are less interested in the subjects taught at school, then they will have little motivation to learn. Emphasizing student interests involves getting to know students well and teaching according to what motivates them. When students develop good feelings about their work because they enjoy it, and teachers combine activities that interest students with a nurturing environment, students tend to respond positively (Ellis, 2010). Teachers can emphasize student interests by providing time for students to participate in independent study, a teaching method that allows students to learn what they are specifically interested in. Another strategy is to show students how the course material relates to topics in which the students are interested. Using appropriate starting points emphasizes the application of the zone of proximal development.

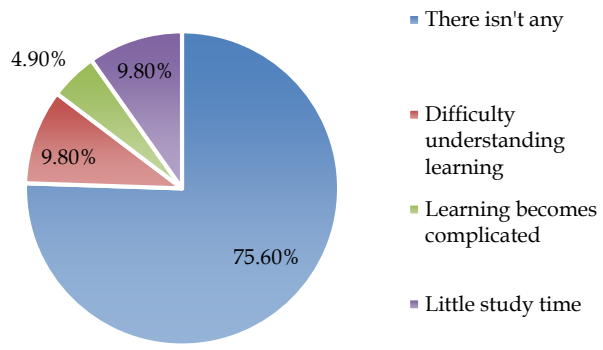

Figure 5. Obstacles during differentiated learning at SMAN 14 Bekasi

It can be seen in the picture above that 75.6% answered that there were no obstacles, meaning that almost half of them liked this differentiated learning. There were 9.8% who answered that it was difficult to understand because, during an interview with Mrs. F. as

the chemistry teacher, she explained that at the beginning the learning felt a bit heavy and difficult, but after coming here many realized that this was the learning they wanted. Meanwhile, 9.8% of students answered that there was not enough time, which is true in accordance with the conditions in the field where there is a lot of material that we have to convey, but only a little time is hindered. However, this does not affect the students' enthusiasm for learning.

The following are the results of filling out a questionnaire on the difficulty of understanding chemistry for students at SMAN 53 Jakarta, SMAN 30 Jakarta, and SMAN 14 Bekasi City Class X, which can be seen in the diagram below:

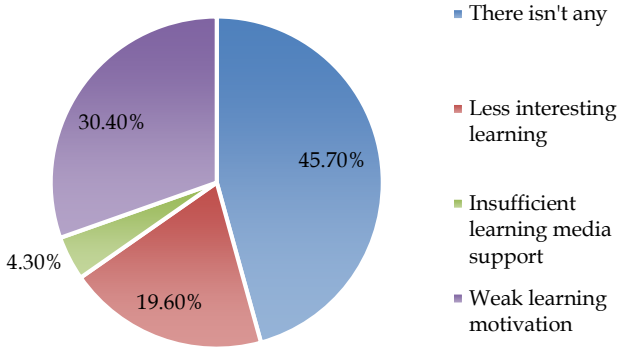

Figure 6. Difficulty understanding chemical material during differentiated learning SMAN 53 Jakarta

It can be seen in the diagram above that 45.7% of the students at SMAN 53 Jakarta answered that they had no difficulty in understanding the chemistry material, but 30.4% of the students answered that because their learning motivation was weak so they had difficulty understanding the learning material, especially in chemistry material and 19.6% of students answered that the learning given by the teacher was not interesting so that was a factor in them having difficulty understanding the learning, especially in chemistry material. After conducting an in-depth interview regarding this matter, the chemistry teacher in question said that most of the students were afraid to ask questions directly and when they were not clear, usually after class was over, some of them dared to WhatsApp the teacher if they wanted to ask questions about the lessons that had been taught., so that at that time the teacher gave the students the opportunity. If something is not clear later, please come to the teacher's room if I have free time and please ask anything that is not clear. However, there are some who only ask peer tutors.

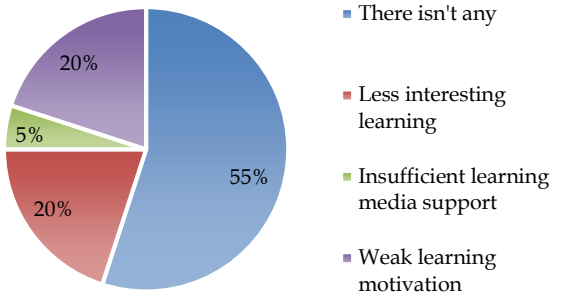

Figure 7. Difficulty understanding chemical material during differentiated learning in SMAN 30 Jakarta

It can be seen in the picture above that 20% of students answered that motivation for learning was weak. In fact, the teacher always provides motivation during learning, but perhaps because it doesn't resonate with the students, students find it difficult to understand the learning, especially chemistry material. And 20% of students answered that the learning system provided by the teacher in class was less interesting so they were not enthusiastic and had difficulty understanding the learning material, especially chemistry. And 55% answered that they did not experience any difficulties or obstacles during the learning process regarding chemistry material because as explained at the beginning, only half of the classes when studying chemistry were enthusiastic or did not experience difficulties when studying chemistry in class. Apart from that, on average, when they have difficulty understanding their learning, they are embarrassed and afraid to ask questions and their peers also don't want to help each other teach other friends so they only focus on themselves except when there is an order from the teacher.

Additional strategies teachers can use include asking students for help and practicing with digital resources. Hicks (2011) discussed that asking students for help makes students feel important and benefits students with behavior problems. With academic abilities varying widely, teachers need to teach at a level that suits students' abilities and learning styles. This result can be achieved through several strategies. The first method that teachers can apply is the theory of multiple intelligences. Because students learn in different ways, teachers need to vary their teaching approaches to use the style that best suits a particular student (Aslanci et al., 2023). Other methods include providing more scaffolding for students who lack basic skills and challenging students above grade level to teach according to the zone of proximal development.

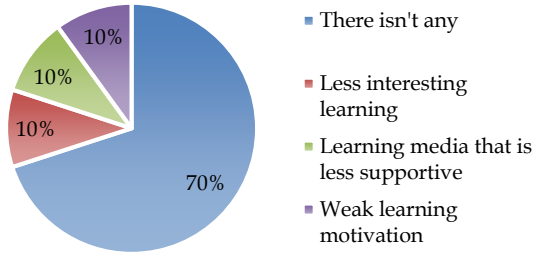

Figure 8. Difficulty understanding chemical material during differentiated learning in SMAN 14 Bekasi

In the diagram above, it can be seen that 70% of students answered that they did not experience obstacles or difficulties in studying differentiated learning, especially in chemistry lessons. The remaining 10% answered that learning was not or less interesting, the learning media was less supportive, and low motivation to learn. Indeed, when in the field there are some students who enter class but don't like learning chemistry, so this is one of the obstacles because the teacher cannot force them to like learning chemistry all in one class.

Product Evaluation

Product evaluation is an assessment of teaching results. The goal is to conduct instructional product evaluations, where instructors try to find out whether instructional ideas really make a difference. Product evaluation can determine whether the curriculum should be modified, refined, or discontinued and can also evaluate the output of curriculum activities. Based on information related to background, input, process, and so on, refers to comparing the difference between results and predetermined standards or absolute standards. It can provide reasonable explanations and consultation for decision-making. The aim is to evaluate the curriculum plan at the endgame or certain gradations.

The following are the results of filling out a questionnaire on understanding chemistry material with differentiated learning for students at SMAN 53 Jakarta, SMAN 30 Jakarta, and SMAN 14 Bekasi Class X, which can be seen in the diagram below:

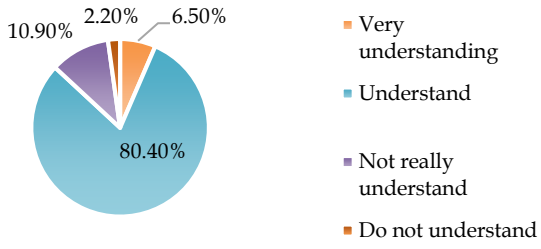

Figure 9. Level of understanding of chemical material during differentiated learning in SMAN 53 Jakarta

It can be seen in the diagram above that almost all students answered that it was easy to understand learning using differentiated learning methods and there were several students who answered that they did not understand, namely around 10.9% of the 4 classes or around 120 students. This is because there are some who are not very clear about what the teacher has explained but they do not dare to ask directly so their understanding is not immediately complete. And 80.4% of students understand learning with a differentiation system. Because almost all students think learning is easier and the material presented by teachers is more innovative students learn effectively and efficiently, especially chemistry material.

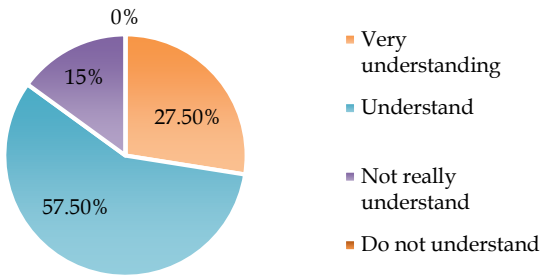

Figure 10. Level of understanding of chemical material during differentiated learning in SMAN 30 Jakarta

It can be seen in the diagram above that 57.5% were able to understand chemistry learning using a differentiation system, because the teacher always provides treatment according to each student's abilities. So it can be concluded that as far as differentiated learning is implemented in the classroom, it can make students easily understand learning, especially chemistry material. Because learning is not only carried out according to the interests and learning styles of each student here, it turns out to be more effective and efficient because teachers are also helped by not having to use the lecture system all the time. Meanwhile, around 27.5% of the 120 students (4 classes) felt that they did not understand or had difficulty understanding chemistry learning, because they did not like chemistry material, even though the learning was in accordance with their respective learning styles. Apart from them feeling that it is not their favorite subject, the teacher also does not force them to like all chemistry material because whatever the field, if they want to learn, Mr. R. as a chemistry teacher at SMAN 30 Jakarta also said that I always respect the process of each child, no matter what the end result is, what is important is that the process is that they want to learn and want to be active during the learning process.

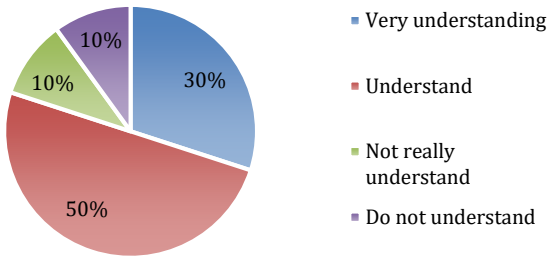

Figure 11. Level of understanding of chemical material during differentiated learning in SMAN 14 Bekasi

Based on the diagram above, from the 4 classes, around 50% and 30% of the students answered that they understood or comprehended the differentiated learning given, especially in chemistry. Because they realize that the learning has been carried out according to their respective levels or levels of ability. So they don't feel burdened when studying and they feel learning is comfortable. Meanwhile, 10% answered that they didn't understand or didn't understand this because, as explained at the beginning, even though the learning had been given according to the interests, readiness and learning style of each student, not all students liked chemistry lessons so these students had some difficulty accepting or absorbing the learning that had been taught given.

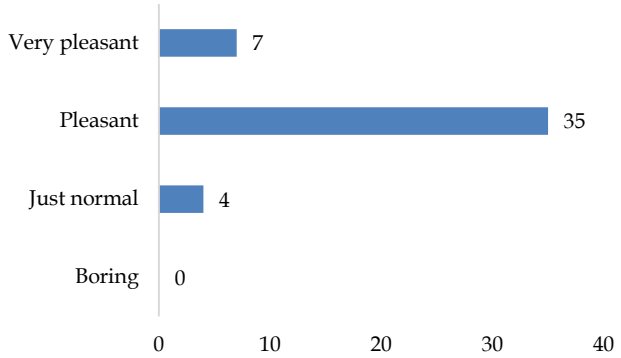

Figure 12. Level of assessment of chemical material during differentiated learning in SMAN 53 Jakarta

Based on the results of interviews and questionnaire results, it shows that almost all students really like learning chemistry through project media, because almost all students learn enthusiastically and easily understand the material presented and one student at SMAN 53 Jakarta said "Learning is fun because "By using projects as a way to convey chemistry material, it makes me understand the material better. "The results of the questionnaire can be seen in Figure 12.

During interviews with students at SMAN 30 Jakarta, on average all of them liked differentiated learning, especially when using project media. As Maulin Anifah said during an interview where he said " It was really fun. Projects in chemistry learning can make the material more interactive and practical. Through projects, you can experience chemical concepts directly, explore deeper understanding, and develop creativity in more interesting ways. As seen in Figure 13.

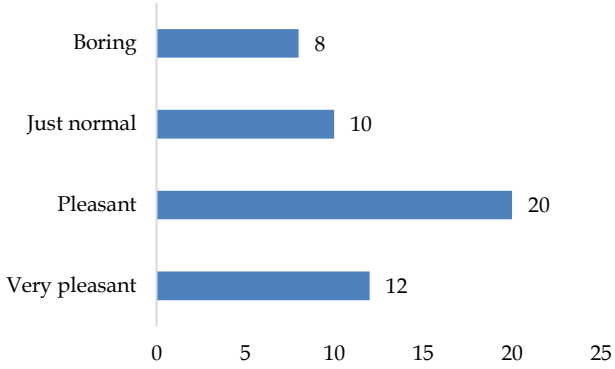

Figure 13. Level of assessment of chemical material during differentiated learning in SMAN 30 Jakarta

In the interview process with students at SMAN 14 Bekasi, almost all students liked learning chemistry with projects, because they felt learning was interesting and fun. So that they can explore learning according to their respective levels and abilities without feeling burdened and can do everything according to the results of their own work. That differentiated learning is appropriate and students are enthusiastic about participating in the learning, both those who like and those who don't like learning chemistry as seen in Figure 14.

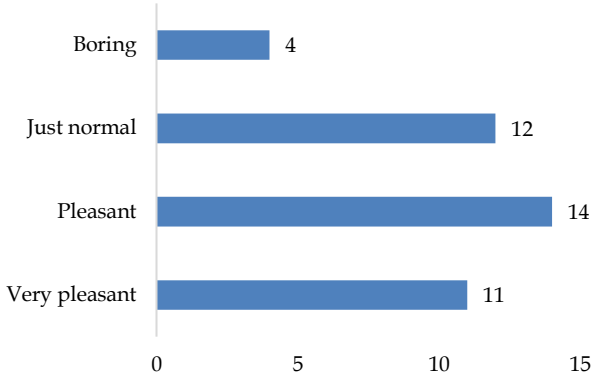

Figure 14. Level of assessment of chemical material during differentiated learning in SMAN 14 Bekasi

Apart from that, here are some answers from students regarding what hopes they want in the future as seen in Table 4.

Table 4. Results of the Questionnaire on the Expectations of Class X Students at SMAN 53 Jakarta

I hope that chemistry learning can be developed to be more interesting so that it can increase students' interest in learning, as well as reduce group assignments because personally, group assignments are a burden for me, especially if the members cannot be invited to work together.
My hope is that especially in chemistry material, we can use more metaphors that can be directly accepted step by step.
Hopefully, the future will be interesting.
I hope that learning in the field of chemistry can have a good impact on everyday life and can also be applied to overcome problems related to substances in everyday life.
The hope is that in the future the learning can be more friendly towards students who can be said to have little understanding of chemistry material.
Can apply the moving class method, so that we can make friends and get to know more people.
Practice more, and cover the material in a manner that is not boring.
Be given a note about something specific.

Table 5. Results of the Questionnaire on the Expectations of Class X students at SMAN 30 Jakarta

I hope this differentiation material can motivate students, especially students who don't like chemistry, how can teachers get these students interested in learning chemistry.
Want an interesting project or experiment.
I hope that I can continue to follow chemistry material with enthusiasm and always want to dig deeper into projects in chemistry.
Hopefully, by learning according to my interests and passions, my abilities can improve and I can understand chemistry lessons better.
My hope is that teachers will continue to improve the quality of their teaching and provide as many practice questions as possible. explain it slowly.
Keep up the way you teach.
My hope is that I want to understand chemistry more deeply because my dream is to become a pharmacist.

From the results of the questionnaire above, it can be concluded that almost all students are interested in and like differentiated learning, especially in chemistry. Tomlinson (2010), one of the leading researchers on differentiated learning discusses that, in addition to providing effective instruction to all students, differentiated instruction and its subset, personalized instruction, are especially useful for students who do not fit the mold. For these students, he recommends three strategies when implementing this teaching approach that can most powerfully emphasize student interests, use appropriate starting points, and let students work at their own pace.

Table 6. Results of the Questionnaire on the Expectations of Class X students at SMAN 14 Bekasi

I hope that learning in the field of chemistry can be applied in everyday life.
My hope is that in the future we will always be given interesting projects so that the learning process doesn't get boring easily.
Hopefully, this differentiated learning will always be applied to all other subjects including chemistry lessons.
The hope is that differentiated learning in chemistry lessons will be made even more interesting in the future.
The hope is that teachers can make chemistry lessons always interesting.
Hopefully there will be less work in the future.
With this differentiated learning, I really like learning

Although differentiated learning is designed to benefit all students, it requires extraordinary hard work by knowledgeable and well-prepared teachers. Using this teaching approach effectively will definitely help students learn and lead all students to do their best work. This teaching strategy could be the most important trend for a better future for the education system.

Tomlinson (1999) suggests that differentiated instruction includes modifying content, process, and product instructions. The content must be challenging but manageable, otherwise students will fall behind and still be hopeless. This principle fits Vygotsky's Zone of Proximal Development (ZPD), which is defined as the difference between the learner's actual mental age and the attainable level achieved in the field (Bigge et al., 2004). Modifying content is effective when appropriate to progress a person's development and within the range of his or her development. Additionally, content modification is a must to emphasize key dimensions of instruction for desired learning outcomes. Focus on The essence of teaching is one of the principles that teachers must keep in mind for effective differentiation. Learners tend to forget more than remember every piece of information.

Modifying instructional processes, on the other hand, involves implementing a variety of activities, techniques, and teaching strategies to help students

understand the meaning and understand the underlying principles. Matter this requires teachers to organize instruction in a logical sequence from easy to difficult, concrete to abstract, levels of understanding simple to complex (Brown, 2015; Gagne et al., 2005). Experienced teachers can use strategic methods to communicate lesson content to students in the easiest way to understand, no matter how difficult it is. Objective the main purpose of modifying the instructional process is to make each lesson meaningful and applicable to the participants educate in an academically enriched context. Lastly, modifying a product refers to evaluating what it is students understand and how well they can understand a concept. This can be assessed with various forms of assignments, where students can reflect on what they have learned and how they can apply theoretical concepts to practical situations. Assessment must include what has been taught to students during instruction and must be carried out regularly with feedback provided to students immediately.

New evidence emerges regularly to support the premise that not all children learn in the same way (Guild, 2001). It is clear that awareness of different learning styles is a significant tool for understanding differences and fostering student development (Strong, Silver, and Perini, 2001). Educational models based on learning styles have equipped teachers with the ability to plan lessons and curricula, considering how students learn best (Strong et al., 2001). Being able to identify students' learning styles and teaching to accommodate these can help students achieve better academic outcomes and improve their attitudes toward learning (Green, 1999). Identifying learning styles allows a teacher to capitalize on students' strengths and become familiar with concepts they find challenging (Green, 1999). Fine (Schoop, 2000) reported significant gains in test scores of students in special education programs, after their preferred learning styles were incorporated into instruction. Students' performance is significantly better when they are instructed through a learning style approach rather than traditional teaching methods (Fine, 2003). In addition, students' attitudes toward learning improved significantly, as they felt that their individual strengths were accommodated (Fine, 2003).

From the results of questionnaires filled out by chemistry teachers at SMAN 53 Jakarta, SMAN 30 Jakarta and SMAN 14 Bekasi, the student's final grades increased by 100% as can be seen in Figure 15.

From the results of interviews with several students, although at first adapting to differentiated learning felt difficult, now after adapting the students' interest in learning has increased over time. Because they feel that studying is not burdensome because it is in accordance with their respective learning interests.

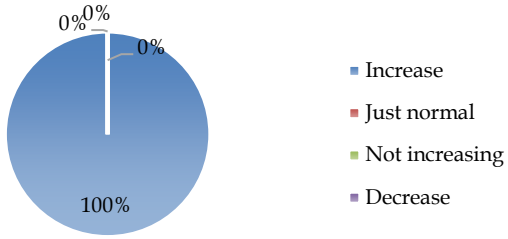

Figure 15. Student scores after using differentiated learning methods

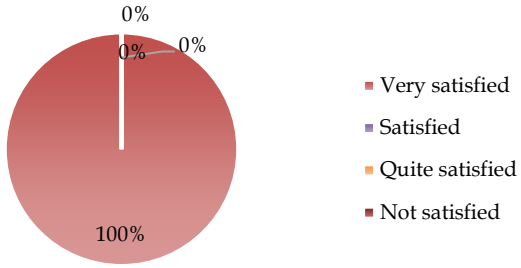

Figure 16. Level of teacher satisfaction with the differentiated learning system

It can be seen in Figure 16 above, where 100% of teachers answered that they were satisfied with the differentiated learning model because apart from increasing students' grades, their interest in learning also increased so that students could learn according to their respective readiness so that teachers were also helped because of the short time constraints. Teachers can achieve learning goals at the same time to achieve student success parameter values and the learning goals are achieved.

From the results of interviews with chemistry teachers at each school, each teacher has different learning methods and models. Where Mrs. Y., as a chemistry teacher at SMAN 53 Jakarta, only focuses on her learning methods according to each student's learning style and readiness. Meanwhile, Mr. R., as the chemistry teacher at SMAN 30 Jakarta, only focuses on the learning system according to the individual learning styles of his students. Mrs. F. as the chemistry teacher at SMAN 14 Bekasi focuses on the learning system according to the interests, talents, and learning styles of each student. This also influences each percentage of success and student interest in the teaching and learning process.

From the explanation above, it is the same as the last model, namely context as a social situation. This is in accordance with the criteria for success in chemistry education described by Gilbert (2006), perhaps more effective than other models. However, Gilbert (2006) strongly recommends using (1998) a comprehensive

model consisting of six elements for good chemistry education: Ideal curriculum focuses on how the curriculum is understood and how the context is related to chemical concepts in the curriculum, Authoritative curriculum refers to a written context-based curriculum that combines all the elements of good chemistry education, Perceived curriculum means the interpretation of its users and teachers, thus, teacher beliefs play an important role in this interpretation, Operational curriculum implies the actual teaching and learning process (i.e. rapid feedback provided by the evaluation team), Curriculum experience contains learning experiences felt by students and Achievement of the curriculum is related to student learning outcomes, and is assessed in relation to consistency or compatibility with the curriculum method used ideal.

An important strategy for differentiating instruction in the twenty-first century that will likely benefit students greatly involves the effective implementation of technology. Since today's students tend to be more engaged while using technology and may find traditional approaches less motivating, teaching effectively with digital resources should help teachers instruct in a manner that matches the learning styles of their students. Additionally, digital resources can easily be used to provide support for struggling learners and offer a way for them to learn through various formats that match auditory, kinesthetic, and visual learning styles. Brain research supports the notion that digital natives are more stimulated through digital resources than material in print format (Prensky, 2001).

Conclusion

From the research that has been carried out, it can be concluded that the results of differentiated learning evaluations on chemistry material use the CIPP (Context, Input, Process and Product) evaluation model. Based on the context component, the school has implemented differentiated learning for all teachers to implement, through representatives of the school curriculum sector socializing differentiated learning activities through in-house training (IHT) in accordance with the regulations of Minister of Education and Culture Regulation No. 61 of 2014. Input component, each chemistry teacher has their own strategy so that learning objectives are achieved according to the level or ability level of each student. In terms of process components, differentiated learning in all high schools that researchers have studied uses the same platform, namely Google Form (for pretest) and YouTube (for visual students). The product components show an increase in learning outcomes which is characterized by increased interest in learning and students who are more active. So that learning activities with a differentiated system are stated to be quite effective, especially in chemistry material. This research only involved representatives from the curriculum field, high school chemistry teachers, and high school students. So it is only limited to certain environments, it is hoped that future researchers will further explore all driving teachers both in public and private high schools. This CIPP evaluation model is quite effective in being used to evaluate differentiated learning systems so future researchers are expected to try using this CIPP evaluation model to evaluate other learning systems.

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Author Contributions

Conceptualization, S.M.; T.D.S.R; and E.E.; methodology, S.M.; T.D.S.R; and E.E.; validation, S.M.; T.D.S.R; and E.E.; formal analysis, T.D.S.R.; investigation, T.D.S.R.; data curation, S.M.; T.D.S.R; and E.E.; writing—original draft preparation, T.D.S.R.; writing—review and editing, T.D.S.R.; and I.I. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest

The authors declare no conflict of interest.

References

Aslanci, S., & Bayrak, A. (2023). Bibliometric Analysis of The Articles Published on Augmented Reality Between The Years of 2010-2021. *Journal of Educational Technology and Instruction*, *2*(1), 15–29. Retrieved from https://ijeti-edu.org/index.php/ijeti/article/view/37%0Ahttps://ijeti-edu.org/index.php/ijeti/article/download/37/12

Barker, V., & Millar, R. (2000). Students' reasoning about basic chemical thermodynamics and chemical bonding: what changes occur during a context-based post-16 chemistry course? *International Journal of Science Education*, *22*(11), 1171–1200. https://doi.org/10.1080/09500690050166742

Bennett, J., Gräsel, C., Parchmann, I., & Waddington, D. (2005). RESEARCH REPORT. *International Journal of Science Education*, *27*(13), 1521–1547.

https://doi.org/10.1080/09500690500153808
Bigge, M., & Shermis, S. (2004). *Learning theories for teachers* (6th ed.). Boston, MA: Pearson.
Brown, A. H. (2015). *The Essentials of Instructional Design*. Routledge. https://doi.org/10.4324/9781315757438
Carter, T. L. (2009). Millennial expectations, constructivist theory, and changes in teachers preparation course. *SRATE Journal*, *18*(1), 25–31. Retrieved from https://files.eric.ed.gov/fulltext/EJ948666.pdf
Checkley, K. (1997). The First Seven and the Eighth: A Conversation with Howard Gardner (Teaching for Multiple Intelligences). *Educational Leadership*, *55*(1), 8–13. Retrieved from https://rb.gy/p1851c
Cook, D. A., Gelula, M. H., Dupras, D. M., & Schwartz, A. (2007). Instructional methods and cognitive and learning styles in web-based learning: report of two randomised trials. *Medical Education*, *41*(9), 897–905. https://doi.org/10.1111/j.1365-2923.2007.02822.x
Demircioğlu, H., Demircioğlu, G., & Çalik, M. (2009). Investigating the effectiveness of storylines embedded within a context-based approach: the case for the Periodic Table. *Chemistry Education Research and Practice*, *10*(3), 241. https://doi.org/10.1039/b914505m
Ellis, A. (2010). *Teaching and learning elementary social studies*. New York: Pearson.
Fine, D. (2003). A sense of learning style. *Principal Leadership*, *4*(2), 55–60.
Gagne, R. M., Wager, W. W., Golas, K. C., Keller, J. M., & Russell, J. D. (2005). Principles of instructional design, 5th edition. *Performance Improvement*, *44*(2), 44–46. https://doi.org/10.1002/pfi.4140440211
Gardner, H. (1983). *Frames of mind: The theory of multiple intelligences*. New York: Basic Books.
Gilbert, J. K. (2006). On the Nature of "Context" in Chemical Education. *International Journal of Science Education*, *28*(9), 957–976. https://doi.org/10.1080/09500690600702470
Gonzales, G. H. A., Despe, K. B., Iway, L. J., Genon, R. J. S., Intano, J. O., & Sanchez, J. M. P. (2023). Online Collaborative Learning Platforms in Science : Their Influence on Attitude, Achievement, and Experiences. *Journal of Educational Technology and Instruction*, *2*(2), 1–16. Retrieved from https://ijeti-edu.org/index.php/ijeti/article/view/55
Green, F. E. (1999). Brain and learning research: Implications for meeting the needs of diverse learners. *Education-Indianapolis-*, *119*(4), 682–687. Retrieved from http://files.rgassman.webnode.com/200000020-2476525702/brain and learning A1.pdf
Grimes, K. J., & Stevens, D. D. (2009). Glass, Bug, Mud. *Phi Delta Kappan*, *90*(9), 677–680. https://doi.org/10.1177/003172170909000914
Guild, P. B. (2001). *Diversity, Learning Style and Culture*. New Horizons for Learning.
Hicks, S. D. (2011). Technology in Today's Classroom: Are You a Tech-Savvy Teacher? *The Clearing House: A Journal of Educational Strategies, Issues and Ideas*, *84*(5), 188–191. https://doi.org/10.1080/00098655.2011.557406
Hsieh, P. H., & Dwyer, F. (2009). The instructional effect of online reading strategies and learning styles on student academic achievement. *Educational Technology and Society*, *12*(2), 36–50. Retrieved from https://eric.ed.gov/?id=EJ836290
Kapusnick, R. A., & Hauslein, C. M. (2001). The "silver cup" of differentiated instruction. *Kappa Delta Pi Record*, *37*(4), 156–9. Retrieved from https://www.ccgedu.net/uploads/8/5/6/8/85683126/thesilvercupofdifferentiation_1_.pdf
Keefe, J. W. (2007). What is Personalization? *Phi Delta Kappan*, *89*(3), 217–223. https://doi.org/10.1177/003172170708900312
LeDune, C., & Chametzky, B. (2023). An instrumental exploratory case study on educators' perceptions of professional development for 1:1 technology use. *Journal of Educational Technology and Instruction*, *3*(1), 14–28. Retrieved from https://ijeti-edu.org/index.php/ijeti/article/view/72
Madaus, G. F., Stufflebeam, D., & Scriven, M. S. (1983). Program Evaluation. In G. Madaus, M. Scriven, & D. Stufflebeam (Eds.), *Evaluation Models* (pp. 3–22). Springer Netherlands. https://doi.org/10.1007/978-94-009-6669-7_1
Nicholson, T. (2014). Using the GPP model to evaluate reading instruction. *J. of Reading*, *32*(4), 312–318. Retrieved from https://www.jstor.org/stable/40029929
Nordlund, M. (2003). *Differentiated instruction: Meeting the educational needs of all students in your classroom*. Lanham, MD: Scarecrow Press.
Orlich, D., Harder, R., Callahan, R., Trevisan, M., & Brown, A. (2004). *Teaching strategies: A guide to effective instruction* (7th ed.). Boston, MA: Houghton Mifflin.
Pashler, H., McDaniel, M., Rohrer, D., & Bjork, R. (2008). Learning styles: Concepts and Evidence. *Psychological Science in the Public Interest*, *9*(3), 105–119. https://doi.org/10.1111/j.1539-6053.2009.0103
Pilot, A., & Bulte, A. M. W. (2006a). The Use of "Contexts" as a Challenge for the Chemistry Curriculum: Its successes and the need for further development and understanding. *International Journal of Science Education*, *28*(9), 1087–1112.

https://doi.org/10.1080/09500690600730737
Pilot, A., & Bulte, A. M. W. (2006b). Why Do You "Need to Know"? Context-based education. *International Journal of Science Education*, *28*(9), 953–956. https://doi.org/10.1080/09500690600702462
Potter, N. M., & Overton, T. L. (2006). Chemistry in sport: context-based e-learning in chemistry. *Chem. Educ. Res. Pract.*, *7*(3), 195–202. https://doi.org/10.1039/B6RP90008A
Powell, K. C., & Kalina, C. J. (2009). Cognitive and Social Constructivism: Developing Tools for an I Effective Classroom. *Education*, *130*(2), 241–250. Retrieved from https://rb.gy/sq2173
Prensky, M. (2001). Digital Natives, Digital Immigrants Part 1. *On the Horizon*, *9*(5), 1–6. https://doi.org/10.1108/10748120110424816
Schoop, T. (2000). Motion and emotion. *American Journal of Dance Therapy*, *22*(2), 91–101. https://doi.org/10.1023/A:1026530307794
Schwartz, A. T. (2006). Contextualized Chemistry Education: The American experience. *International Journal of Science Education*, *28*(9), 977–998. https://doi.org/10.1080/09500690600702488
Silver, H. F., Strong, R. W., & Perini, M. J. (2000). *So each may learn: Integrating learning styles and multiple intelligences*. Alexandria, VA: ASCD.
Stolk, M. J., Bulte, A. M. W., de Jong, O., & Pilot, A. (2009a). Strategies for a professional development programme: empowering teachers for context-based chemistry education. *Chem. Educ. Res. Pract.*, *10*(2), 154–163. https://doi.org/10.1039/B908252M
Stolk, M. J., Bulte, A. M. W., de Jong, O., & Pilot, A. (2009b). Towards a framework for a professional development programme: empowering teachers for context-based chemistry education. *Chem. Educ. Res. Pract.*, *10*(2), 164–175. https://doi.org/10.1039/B908255G
Tobin, R., & McInnes, A. (2008). Accommodating differences: variations in differentiated literacy instruction in Grade 2/3 classrooms. *Literacy*, *42*(1), 3–9. https://doi.org/10.1111/j.1467-9345.2008.00470.x
Tomlinson, C. (1999). *Differentiated classroom: Responding to the needs of all learners*. Association for Supervision and Curriculum Development.
Tomlinson, C. A. (2010). One kid at a time. *Educational Leadership*, *67*(5), 12–16.
Vygotsky, L. S. (19787). *Mind in society*. Cambridge, MA: Harvard University Press.
Warju, W. (2016). Educational Program Evaluation using CIPP Model. *Innovation of Vocational Technology Education*, *12*(1). https://doi.org/10.17509/invotec.v12i1.4502
Wilson, S. (2009). Differentiated instruction: How are design, essential questions in learning, assessment, and instruction part of it? *New England Reading Association Journal*, *44*(2), 68–75. Retrieved from https://www.proquest.com/docview/206037551?sourcetype=Scholarly Journals