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Development of E-Book on The Implementation of Differentiated Learning For Chemistry Teachers

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Abstract: Development of E-Book on The Implementation of Differentiated Learning for Chemistry Teachers. Various education problems in Indonesia such as learning crises, learning loss, and the low PISA ranking in 2022 require a concrete solution. One of the efforts is through the implementation of the independent curriculum since 2021. In realizing these efforts, the Independent Curriculum carries a student-oriented learning paradigm which is implemented differentiated learning. However, the fact encountered is that there are still many teachers who do not understand how to carry out differentiated learning. The purpose of this study is to find out the validity of the E-book Guidelines for the Implementation of Differentiated Learning for Teachers in Chemistry Learning Phase E of High School/MA Equivalent by using a 4D development model consisting of Define, Design, Develop and Deseminate. The instrument used is a validity questionnaire. The validity tested includes the validity of the content (chemistry and differentiated learning), graphics and language. The data collection technique is carried out by distributing questionnaire instruments and practicality sheets that have been valid. The data was analyzed by processing alternative answers contained in the questionnaire and then transformed into quantitative data to obtain interval data using the kappa moment. The results obtained were the validity of the chemistry content with a value of 0.7365 with a valid category, the validity for differentiated learning content with a value of 0.87 with a very valid category.Based on the results of the research and discussion, it can be concluded that the development of E-Book on The Implementation of Differentiated Learning for Chemistry Teachers is valid and very feasible to be used in learning activities.

Keywords: chemistry, differentiated learning, e-book.

Abstrak: Pengembangan E-Book Panduan Implementasi Pembelajaran Berdiferensiasi Bagi Guru Kimia. Berbagai permasalahan pendidikan di Indonesia seperti krisis pembelajaran, learning loss, dan rendahnya peringkat PISA pada tahun 2022 membutuhkan solusi yang konkret. Salah satu upayanya adalah melalui penerapan kurikulum merdeka sejak tahun 2021. Dalam mewujudkan upaya tersebut, Kurikulum Merdeka mengusung paradigma pembelajaran berorientasi pada siswa yang diimplementasikan dalam pelaksanaan pembelajaran berdiferensial. Namun, fakta yang

ditemui adalah masih banyak guru yang belum mengerti bagaimana melakukan pembelajaran yang berbeda. Tujuan penelitian ini adalah untuk mengetahui keabsahan E-book Pedoman Pelaksanaan Pembelajaran Berdiferensiasi bagi Guru dalam Pembelajaran Kimia Tahap E SMA/MA Setara dengan menggunakan model pengembangan 4D yang terdiri dari Define, Design, Develop dan Deseminate. Instrumen yang digunakan adalah kuesioner validitas. Validitas yang diuji meliputi validitas konten (kimia dan pembelajaran yang diferensiasikan), grafik dan bahasa. Teknik pengumpulan data dilakukan dengan membagikan instrumen kuesioner dan lembar kepraktisan yang telah valid. Data tersebut dianalisis dengan mengolah alternatif jawaban yang terdapat dalam kuesioner dan kemudian diubah menjadi data kuantitatif untuk mendapatkan data interval menggunakan momen kappa. Hasil yang diperoleh adalah validitas konten kimia dengan nilai 0,7365 dengan kategori valid, validitas konten pembelajaran difertilasi dengan nilai 0,87 dengan kategori sangat valid. Berdasarkan hasil penelitian dan diskusi, dapat disimpulkan bahwa pengembangan E-Book tentang Implementasi Pembelajaran Berdiferensiasi bagi Guru Kimia adalah valid dan sangat layak untuk digunakan dalam kegiatan pembelajaran.

Kata kunci: Kimia, Pembelajaran Berdiferensiasi, E-Book

▪ INTRODUCTION

Various education problems in Indonesia such as learning crises, learning loss, and the low PISA ranking in 2022 (OECD, 2023) require a concrete solution. One of the efforts is through the implementation of the independent curriculum since 2021 (Kurnia Fitra, 2022). In realizing these efforts, the Independent Curriculum carries a different paradigm from the previous Curriculum. The paradigm emphasizes that learning is student-oriented. The student-oriented learning paradigm includes the ability of teachers to map competency standards, independent learning and competence in conducting assessments. This paradigm provides a guarantee for teachers to have the freedom to formulate learning plans and assessments that are in accordance with the characteristics of students and this paradigm can be implemented through differentiated learning (Fauzi et al., 2023). The Independent Curriculum itself has its own learning characteristics. The characteristics of learning in the Independent curriculum are as follows: 1) Pancasila students who aim to develop soft skills and character in accordance with students' talents so that they benefit from project-based learning. 2) Focus on essential information so that there is plenty of time available to learn basic skills such as reading and counting in depth. 3) Teachers' ability to adapt learning to the preferences and learning skills of each student, including those with special needs, (Ningrum et al., 2023). In this context, differentiated learning can be the right strategy to implement the Independent Curriculum (Halimah Nurul et al., 2023). Before the enactment of the Independent Curriculum, the pedagogical world had actually long paid attention to the concept of learning that accommodated the diversity of student conditions or differentiated learning. The concept states that each student is unique, because no one is exactly the same in various ways. Each student is unique physically or psychologically. This also happens in pedagogical conditions (Ahmad Teguh, 2022). The concept of differentiated learning is actually in accordance with the educational philosophy proposed by the Father of Indonesian Education, Ki Hajar Dewantara (Herwina, 2021). According to the philosophy of Ki Hajar Dewantara, a teacher is in charge of guiding

children to grow and develop according to their nature in order to achieve security and happiness. According to this philosophy, the task of a teacher is to guide and guide children according to their interests, talents and abilities so that they can be successful and happy (Masitoh & Cahyani, 2020). In differentiated learning, teachers facilitate students based on their needs because each student has unique characteristics, so they cannot be applied equally. However, it needs to be understood that the implementation of differentiated learning is not individualistic learning but accommodates all potentials, strengths and learning needs of students using independent learning strategies (Marlina et al., 2019).

Differentiated learning is the teacher's effort in designing and adjusting the learning process in the classroom in order to meet the learning needs of each individual. Adjustments in this case are related to students' interests, learning profiles, and readiness so that they can improve their learning outcomes (Herwina, 2021). Morgan (Ayu Sri Wahyuni, 2022) states that the definition of differentiated learning is a method of identifying and teaching students based on the learning style and talent of each individual. Marlina revealed that differentiated learning is a repetitive process in the form of a cycle of learning about students and responding to their learning methods based on their differences. According to Marlina, each student has a very diverse potential and each is unique. Each student who comes to study at school is accompanied by uniqueness and diversity inherent in him. These uniqueness and diversity include learning styles (auditory, visual, kinesthetic), academic ability (low, medium, high), speed of understanding lessons (there are students who are fast, medium, and slow in understanding learning materials), learning orientation (performance approach, performance avoidance, performance mastery), motivation (low, medium, high), self-efficacy (high, medium, low), interest (having an interest in certain subjects, such as mathematics, language, science), personality (extrovert or introvert), and socioeconomic status (low, medium, high). Another opinion states that according to Tomlinson, the needs of students in differentiated learning can be grouped into three aspects, namely student learning readiness (readiness), student interests, and student learning profiles such as language, learning style, culture, and others (Suwartiningsih, 2021), while differentiated learning is divided into four aspects, namely differentiation of content, processes, products, and learning environments in the classroom (Wahyuningsari et al., 2022).

Differentiated learning is an important learning pattern. According to Tucker (Gusteti & Neviyarni, 2022) among others, (1) Differentiated learning can provide challenges for students to learn more deeply, (2) Providing opportunities for students to act as peer tutors for other students, (3) Teachers must understand and realize that differentiated learning is a one-size-fits-all phenomenon that cannot meet the same needs, just as the size of clothes sold in stores cannot all fit each other's size. user. Differentiated learning allows teachers to see learning from multiple perspectives, so that teachers can give attention and action to meet the needs of individual students. Through differentiated learning, it is hoped that teachers will be able to carry out a cyclical process of finding out about students' learning responses based on their differences (Sherly et al., 2020). Based on these facts, learning that uses the student equalization approach requires a thorough review. Learning that uses a student equalization approach will not be able to meet the needs of each student, due to diverse

needs and backgrounds. Therefore, a learning approach is needed that can accommodate the needs of each student, namely differentiated learning approaches.

Based on the description of the position of Chemistry in the Independent Curriculum, it is necessary to implement differentiated learning in the implementation process. This is based on the fact that in the process of achieving the Chemistry learning objectives required by the Curriculum and some of the considerations that have been stated above can be achieved by students in accordance with their characteristics, especially the student's learning style and helping students understand the Chemistry knowledge material in accordance with their characteristics. However, in the implementation of differentiated learning in Chemistry subjects, it was found that the problem of not implementing differentiated learning in several high schools in Tanah Dasar Regency was found. Some of the difficulties encountered include that teachers still have difficulty carrying out differentiated learning, especially differentiation of content and processes; Teachers still have difficulty in dividing the allocation of learning time if they try to use differentiated learning in terms of content, products, processes and learning environments; Teachers still have difficulties in developing differentiated learning-based teaching modules; Teachers still do not have a practical guidebook to implement the differentiated learning process. Some of these problems have an impact on student summative learning outcomes which are carried out in the form of UTS and UAS. This can be seen from some data on the average raw score of Chemistry subjects of students from 5 high schools in class X. In general, it can be seen in the following table:

School	X1		X2		X3	
	MID	UAS	MID	UAS	MID	UAS
	Average		Average		Average	
SMA A	62,75	67,89	61,50	66,80	62,70	65,80
SMA B	63,85	69,70	62,70	68,75	63,30	67,75
SMA C	69,50	70,25	68,75	70,50	69,25	70,15
SMA D	64,70	68,50	63,56	67,50	62,70	68,75
SMA E	65,58	69,40	65,50	68,25	64,40	67,25

Table 1. Average raw score of Chemistry subjects of students from 5 high schools in class X

Based on the data from the table above, it can be concluded that the average raw score of students in the 2023/2024 semester and odd semester MID is 65,787 and 69.21. This figure is still categorized as low enough for students to be able to master the CP mandated by the Independent Curriculum. Although it was found that the Chemistry teachers of Tanah Datar Regency have not implemented differentiated learning, they have made efforts to do so. This series of assessments is carried out by the school and teachers to find out the characteristics of students in the context of implementing differentiated learning. However, in its implementation, teachers still have not implemented this differentiated learning and also do not have guidelines to implement it. One way to overcome the inadequacy of differentiated learning is to develop an e-book of differentiated learning guides.

▪ METHOD

This study employed the Research and Development (R&D) approach (Octavia Dwi, Fadliilah; Harun, 2019), utilizing the 4D model by Thiagarajan as the developmental framework (Rezki; Herman, Mimi; Rahmi & Hidayat, 2024). The 4D model, a structured product development methodology, comprises four main phases: Define, Design, Develop, and Disseminate Research methods depend on the research design used (Arfan & Aznam, 2023)(Harahap & Yusuf, 2024)(Herman et al., 2022). The participants of this research are 20 MGMP Chemistry Teachers in Tanah Datar Regency. The selected validators are 3 Chemistry Education Lecturers to validate differentiated learning content and graphics, and 1 person to assess the content of Chemistry material. The instruments used are validity questionnaires for aspects of chemistry content, differentiated learning content, gravising and language that have been validated in advance. Data is collected through the distribution of questionnaires for each aspect to each validator. The type of data used in this study is quantitative data dan data Analysis of the results of the validation by the experts was done using Moment Kappa calculation by calculating the score of each rater from the validation results, then entered into the Moment Kappa formula (Herman & Herman, 2022).

▪ ESULT AND DISCUSSION

1. Define

There are 5 activities in this phase, namely: (1) front-end analysis; (2) learner analysis; (3) task analysis; (4) concept analysis; and (5) specifying instructional objectives (Rahma et al., 2017) (Haviz, 2016).

a) Front-end Analysis

This stage was carried out by interviewing several Chemistry teachers in several schools in Tanah Datar Regency at the beginning of the semester of the 2022/2023 academic year regarding the implementation of differentiated learning in schools. The results obtained from stating that teachers in general have not implemented differentiated learning. In general, teachers have not implemented differentiated learning because of teachers' difficulties in understanding how to implement differentiated learning, obstacles in dividing the implementation time, many variables that must be considered in determining the type of differentiated learning and the absence of technical guidance for its implementation. This causes the learning carried out by Chemistry teachers to still standardize the learning process for each student so that the demands of the Independent Curriculum are not achieved and they state that they need a technical guide to carry out differentiated learning in the Chemistry learning process in schools.

b) Analysis of Students' Characteristics

The characteristics of students that are variable in this study are Student Learning Styles. The student learning styles that are the basis for the implementation of differentiated learning are Visual, Auditory and Kinesthetic learning styles. It is assumed based on the results of the Non-Cognitive Diagnostic Assessment in general, students in each class will consist of students who have Visual, Audio, and Kinesthetic

learning styles. Therefore, the e-guide developed in differentiated learning refers to the three learning styles.

c) Task Analysis

Task analysis aims to identify tasks that will be carried out by students in learning and in task analysis includes deepening the material and achieving learning outcomes (Layin Fauziyah, 2014). In this study, it is related to product differentiated learning.

d) Concept Analysis

The concepts that have been analyzed are the concepts of Chemistry that will be learned by students in Phase E of class X in accordance with the Phase E Learning Outcomes. The Chemistry concepts contained in this E-Book are adjusted to the Chemistry concepts in the Chemistry book used by Chemistry teachers at school, namely the Chemistry Book Class X Independent Curriculum by Unggul Sudarmono published by Erlangga. In addition, a concept analysis was also carried out from the Chemistry book of SMA Independent Curriculum provided by the Ministry of Education and Culture. This was done to standardize the Chemistry material taught by teachers at SMA Regency Tanah Datar.

e) Specifying instructional objectives.

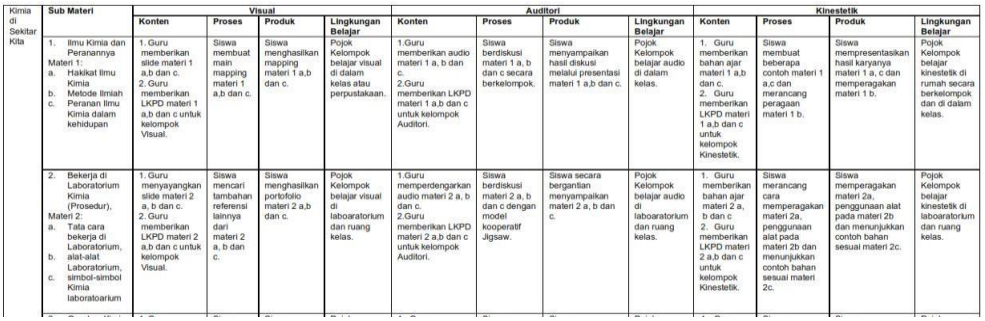
The last stage of analysis that has been carried out is the Curriculum analysis which includes CP, TP and ATP analysis. This analysis is useful for summarizing the results of task analysis and concept analysis into learning objectives (Chintya Rizki*, Liza Yulia Sari, 2023) (Apriliani* et al., 2022). In this analysis of learning objectives, the learning objectives are taken from the Phase E learning outcomes.

2. Design

The design stage includes four phases: (1) constructing a criterion-referenced test; (2) media selection; (3) format selection; and (4) initial design (Apriliani* et al., 2022). Each phase will be described as follows:

Constructing Criterion-Referenced Test is a step that connects the defining stage with the design stage. The preparation of test standards is based on the results of the analysis of learning objectives specifications and student analysis. In the case of this research, the activity is carried out by making a grid for testing the validity of instruments and products. The second stage is media selection. Broadly speaking, the selection of media is carried out to identify learning media that are suitable/relevant to the characteristics of the material. The selection of media is based on the results of concept analysis, task analysis, characteristics of students as users, and dissemination plans using various media variations. In the research that has been carried out, the product that has been made is a differentiated learning guide e-book for the subject of Chemistry phase E. The third stage that has been carried out is to choose a format (format selection). The selection of formats in the development of learning tools aims to formulate the design of learning media, the selection of strategies, approaches, methods, and learning resources (Maydiantoro, 2020). In the research activities that have been carried out, the researcher chose the E-Book format using the PDF Flipbook application. The reason for this selection is that flipbook software has several characteristics with advantages such as being able to create interactive media, learning media, teaching

materials and being able to produce moving images. Researchers use the advantages of flipbook software to create electronic teaching materials as teaching materials that are believed to be able to support learning activities in schools (Wardani & Susilowibowo, 2021). The last step in the design stage is the initial design. The initial plan is the entire E-Book plan to be created. Another activity carried out at this stage is the development of an instrument consisting of a validity questionnaire. The following are some photos of parts of the e-book that have been developed.



Kimia di Sekitar Kita	Sub Materi	Visual				Auditori				Kinestetik			
		Konten	Proses	Produk	Lingkungan Belajar	Konten	Proses	Produk	Lingkungan Belajar	Konten	Proses	Produk	Lingkungan Belajar
	1. Ilmu Kimia dan Peranannya Materi 1: a. Hakikat Ilmu Kimia b. Metode Ilmiah c. Peranan Ilmu Kimia dalam kehidupan	1. Guru memberikan slide materi 1 a,b dan c. 2. Guru memberikan LKPD materi 1 a,b dan c untuk kelompok Visual.	Siswa membuat main mapping materi 1 a,b dan c.	Siswa menghasilkan mapping materi 1 a,b dan c.	Pojok Kelompok belajar visual di dalam kelas atau perpustakaan.	1.Guru memberikan audio materi 1 a, b dan c. 2.Guru memberikan LKPD materi 1 a,b dan c untuk kelompok Auditori.	Siswa berdiskusi materi 1 a, b dan c secara berkelompok.	Siswa menyampaikan hasil diskusi melalui presentasi materi 1 a,b dan c.	Pojok Kelompok belajar audio di dalam kelas.	1. Guru memberikan bahan ajar materi 1 a,b dan c. 2. Guru memberikan LKPD materi 1 a,b dan c untuk kelompok Kinestetik.	Siswa membuat beberapa contoh materi 1 a,c dan merancang peragaan materi 1 b.	Siswa mempresentasikan hasil karyanya materi 1 a, c dan memperagakan materi 1 b.	Pojok Kelompok belajar kinestetik di rumah secara berkelompok dan di dalam kelas.
	2. Bekerja di Laboratorium Kimia (Prosedur). Materi 2: a. Tata cara bekerja di Laboratorium, b. alat-alat Laboratorium, c. simbol-simbol Kimia laboratoarium	1. Guru menyayangkan slide materi 2 a, b dan c. 2. Guru memberikan LKPD materi 2 a,b dan c untuk kelompok Visual.	Siswa mencari tambahan referensi lainnya dari materi 2 a, b dan c.	Siswa menghasilkan portofolio materi 2 a,b dan c.	Pojok Kelompok belajar visual di laboaratorium dan ruang kelas.	1.Guru memperdengarkan audio materi 2 a, b dan c. 2.Guru memberikan LKPD materi 2 a,b dan c untuk kelompok Auditori.	Siswa berdiskusi materi 2 a, b dan c dengan model kooperatif Jigsaw.	Siswa secara bergantian menyampaikan materi 2 a, b dan c.	Pojok Kelompok belajar audio di laboaratorium dan ruang kelas.	1. Guru memberikan bahan ajar materi 2 a, b dan c 2. Guru memberikan LKPD materi 2 a,b dan c untuk kelompok Kinestetik.	Siswa merancang cara memperagakan materi 2a, penggunaan alat pada materi 2b dan menunjukkan contoh bahan sesuai materi 2c.	Siswa memperagakan materi 2a, penggunaan alat pada materi 2b dan menunjukkan contoh bahan sesuai materi 2c.	Pojok Kelompok belajar kinestetik di laboaratorium dan ruang kelas.

Figure 1. some photos of parts of the e-book

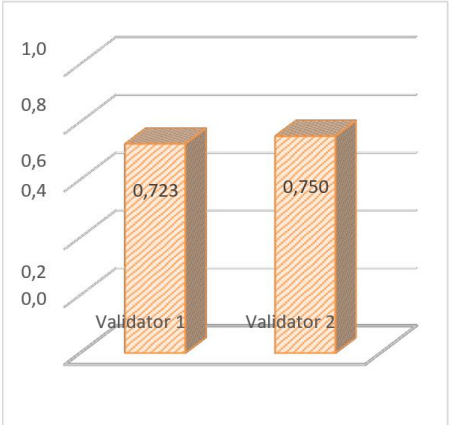
3. Develop

The third stage of this research is the Develop stage. At this stage, validation is carried out on the instruments and E-Books that have been made. Validation is a follow-up to the design stage (Rafida et al., 2022) and the ability to measure exactly what you want to measure (Astuti et al., 2015)(Ningsih & Adesti, 2019). The validation stage is carried out by assessing the product results to validators, namely media experts and material experts who have competence in their respective fields, (b) revisions are made to improve the assessment results by validators. (c) the final product is the result of validation by material experts and media experts which is then continued to the revision stage (Rafida et al.,2022). In line with this opinion, Irnando stated that at this stage, the product must also go through several stages of revision from validators or experts and has been tested to users (Irnando et al., 2020). In the research that has been carried out, the validity test of the instrument and the validity test of the product include Chemistry content and differentiated learning, language validity test and graphic validity test. Content validation is related to the suitability of the material in the product with the

concept of scientific material (Ayu Permata Sari & Suryelita, 2023) and the suitability of the material description with the curriculum, the accuracy of the material, and learning support materials (Nadira et al., 2022). The suggestion from the first validator on the scientific content of Chemistry is the inclusion of references from each material, while the second validator suggests using university standard books as a source of the chemistry content. The suggestion for differentiated learning content is that the concept of differentiated is still vague in the e-books developed. It is necessary to emphasize the "differentiation" in thi ebook whether in the context of the process, content or product or all of them. Maybe it can be equipped with additional instructions or information on the cases given so that there can be seen as an effort to provide a differentiated learning experience for students. After being corrected, the results for the Chemistry content both validators gave a value with a valid category (average 0.73) as diagrams below:

Figure 2. Score Chemical Content Validity by Validator

Based on figure 2, the result of the assessment of the validator 1 in the field of



Chemistry material, the validity of the E-Book developed is 0.723 with a valid category, the validator 2 in the field of Chemistry material assesses the E-Book developed with a score of 0.750 with a valid category, Thus, it is concluded that the E-Book developed has a high validity value so that it is very feasible to be used in the effectiveness test for the learning process. After being corrected, the results for the differentiated learning materials and the learning style content of the E-Book both validators gave a value with a very valid category (average 0.87) as diagrams below:

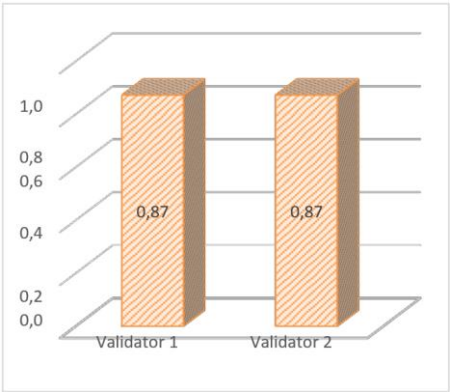


Figure 3. Score Differentiated Learning Validity by Validator

Based on figure 3, the result of assessment of validator 1 in the field of differentiated learning materials and the validity learning style of the E-Book developed with a value of 0.87 with the category categorized as very valid, the validator 2 in the field of differentiated learning materials and learning styles assessed the E-Book developed with a score of 0.87 with the

category of very valid, Thus, it was concluded that the instrument developed has a high validity value so that it is very feasible to be used in the effectiveness test for learning process.

▪ CONCLUSION

The results obtained were the validity of the chemistry content with a value of 0.7365 with a valid category, the validity for differentiated learning content with a value of 0.87 with a very valid category. Thus, it was concluded that the E-book developed has a high validity value so that it is very feasible to conduct an effectiveness test to be used in the Chemistry learning process in schools.

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