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Wankat and Oreovocz problem-solving strategies in ordinary differential equations teaching materials: A development study

Rezi Ariawan*, Zetriuslita

Universitas Islam Riau, Pekanbaru, Riau, 28284, Indonesia
*Corresponding Author: reziariawan@edu.uir.ac.id

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Abstract

Students always experience difficulties in learning ordinary differential equations. The existence of teaching materials that can make students learn actively independently, encourage curiosity, and improve their mathematical abilities is needed. This research aims to produce teaching materials for ordinary differential equations that contain the steps of Wankat and Oreovocz Problem Solving Strategies (I can explore, plan, do it, check, and generalize). This research was conducted in the odd semester of 2023/2024 at the FKIP UIR Mathematics Education Study Program by involving 5th-semester students as product test subjects. Development research was used in this study, using a 4D design (define, design, development, and dissemination). The research instrument consisted of validation sheets and the practicality of teaching materials. Validation of teaching materials was carried out by 3 validators, while the practicality trial of teaching materials was carried out by using teaching materials in the learning process. Data obtained from validators and students will be analyzed descriptively quantitatively, while information related to suggestions, input, and student responses will be analyzed descriptively qualitatively. The teaching materials developed received an assessment with a score of 0.9 or with very valid criteria. While 95% or almost all responses stated that the teaching materials used were very practical, it was still found that students could not learn quickly in completing the tasks.

Keywords: development; Wankat and Oreovocz problem solving strategies; materials; ordinary differential equations

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I. Introduction

Ordinary differential equations are one of the courses taught to prospective mathematics education teacher students. The course of ordinary differential equations plays an important role because it is related to solving problems related to everyday life (Syahri, Satriani, Ma'rup, & Bahar, 2019). For ordinary differential equations, only 13% of students obtained good scores, namely with a score range of 63 ≤ Good ≤ 70 in the midterm exam conducted. Syahri et al. (2019) found that

students' understanding of differential equations was still low. Furthermore, it is stated that there are several causes of low student learning outcomes in differential equations courses, including (1) the use of learning models and strategies that are not included with books or teaching materials that have been prepared following learning outcomes; (2) the usefulness of learning differential equation courses is poorly understood by students; and (3) students do not understand the concept well, students only refer to solving problems. Furthermore, in this course, students generally find it difficult to understand the concept and determine the design; students also tend to forget the prerequisite material for this course (Ariawan and Zetriuslita, 2021; Asyhar and Asmarani, 2016). Students also have difficulty implementing the formula or algorithm of differential equations in problem-solving (Ningsih and Rohana, 2018).

The importance of student mastery in the course of differential equations or ordinary differential equations can be seen in several studies that previous researchers have conducted. Research analyzing learning difficulties in differential equations has been conducted by (Murtafiah, 2017; Octavia and Khotimah, 2016; Sulistyorini, 2017; Sumargiyani and Munawarrahman, 2020; Suryanti, Pramesti, and Sidik, 2022).

The use of learning models or strategies in learning differential equations or ordinary differential equations has been carried out by (Asyhar and Asmarani, 2016; Ningsih and Jayanti, 2016; Ningsih and Rohana, 2018; Vermana and Zuzano, 2018; Yudhanegara, 2015). Furthermore, the use of media or teaching aids in learning differential equations has been carried out by (Hasanuddin and Granita, 2022; Nugraha and Nurullaeli, 2023; Rifandi, Ahmad, and Gusteti, 2020; Rodliyah and Sa'adah, 2021). Furthermore, the development of ordinary differential equation workbooks has been carried out by (Syahri et al., 2019)

Based on some of the above studies, previous researchers have made several efforts to overcome difficulties and improve student mathematical learning outcomes in learning differential equations. However, few studies have found that developing teaching materials can integrate learning models or strategies to make students active in achieving predetermined learning objectives. In this study, researchers developed teaching materials for ordinary differential equations integrated with Wankat and Oreovocz Problem Solving Strategies.

Wankat and Oreovocz Problem Solving Strategies is one problem-solving step consisting of I can Define, Explore, Plan, Do It, Check, and Generalize steps (Linuhung, 2014, 2015; Rahma, 2022). Wankat and Oreovocz developed a problem-solving strategy consisting of several stages, including (1) I can (the stage of arousing motivation, awakening and growing learners' confidence); (2) define (listing known things, asked questions, unknown things, and using images or mind mapping to clarify the problem); (3) explore (stimulating learners to ask questions and guiding to analyze the problem at hand); (4) plan (guide learners to develop their logical thinking skills to analyze the problem and use flowcharts to illustrate the problem; (5) do it (guide learners to estimate possible answers to solve the problem); (6) check (guide students to re-examine the answers made to detect possible errors); (7) generalize (encourage learners to ask questions "what have I learned in this subject? How can the solution be done more efficiently? If the solution is not correct, what should I do?" (Wankat and Oreovicz, 2015)

Several previous studies have used Wankat and Oreovocz Problem Solving Strategies to analyze students' mathematical abilities (Remsis, Ratnaningsih, and Natalliasari, 2021; Sari, Fatih 'Adna, and Mardhiyana, 2020). In addition, some studies use Wankat and Oreovocz Problem Solving Strategies to improve mathematical abilities (Andrayani, 2016; Linuhung, 2015; Rahma, 2022). Furthermore, research develops learning tools using Wankat and Oreovocz Problem Solving Strategies (Munawarah, Saragih, and Napitupulu, 2020).

Based on a review of several previous studies, no research has been found that integrates Wankat and Oreovocz's Problem-Solving Strategies in teaching materials. Then there is also no development of teaching materials in ordinary differential equations courses that integrate Wankat and Oreovocz Problem Solving Strategies. Therefore, researchers developed teaching materials for ordinary differential equations based on Wankat and Oreovocz Problem Solving Strategies.

II. Research Method

The purpose of this research is to produce teaching materials for ordinary differential equations based on Wankat and Oreovocz Problem Solving Strategies that meet the eligibility criteria. Based on these objectives, development research is considered capable of realizing the objectives of this study. Development research is research that develops, refines, and validates effective products that can be used in schools (Emzir, 2020; Sugiyono, 2015; Sukmadinata, 2011).

In development research, several development designs can be used, including the Borg and Gall design, the Thiagarajan stage, which is better known as 4D, the stage according to Robert Maribe Branch, which is better known as ADDIE, and the development stage according to Richey and Klein which is better known as PPE (Hartono, 2019; Sugiyono, 2020). In this study, researchers used the 4-D stage, which consists of Define, Design, Development, and Dissemination, according to Thiagarajan (Rochmad, 2012; Sugiyono, 2020). The research stages are presented in the figure below.

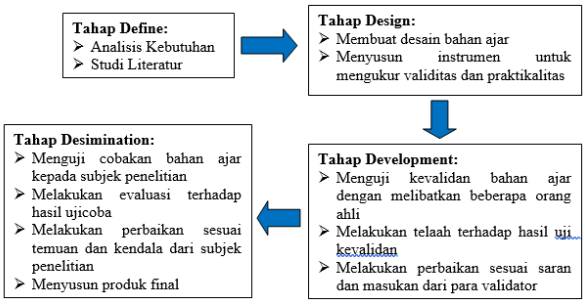


Figure 1: Stages of research

This research was conducted in the Mathematics Education Study Program in the odd semester of 2023/2024. The subjects in this study were students who had passed the differential calculus, integral, and ordinary differential equations courses totaling 43 people.

The data collection instrument used is a validation sheet that uses a Likert scale. Each statement is equipped with four answer options with the interpretation of very suitable = 4, suitable = 3, not suitable = 2, very unsuitable = 1. The aspects and indicators used are presented in the following table.

Table 1. Aspects and indicators of validity test

No.	Aspect Assessment	Indicator	Number of Statements
1	Feasibility of presentation	Systematics presentation	1
		Conciseness of concept	1
2	Feasibility of content	Completeness of material	1
		Breadth of material	1
		Depth of material	1
		Accuracy of material	1
3	Feasibility of learning activities	Suitability with wankat and oreovoct strategies	7
4	Feasibility of Didactic	Suitability with didactic feasibility	4
5	Feasibility of construction	Suitability with construction feasibility	6
6	Feasibility of technical	Suitability with technical feasibility	2
Total Number of Statements			**25**

Source: *Researcher data*

The results of teaching material validation were analyzed using the Aiken index formula (Retnowati, 2016) as follows:

$$V = \frac{\sum s}{n\,(c-1)}$$

Formula Description:

V = Index of rater agreement regarding item validity

s = the score assigned by the rater minus the lowest score in the category used $s = r - I_0$), with r the score of the rater's preferred category and I_0 is the

lowest score in the scoring category
n = Number of raters
c = Number of categories selected by the rater

The results of the validity calculation are then interpreted using the following criteria:

Table 2. Criteria for interpretation of validity of teaching materials

Score obtained	Validity Criteria
V > *0,8*	Very Valid
0,4< $V \leq$ 0,8	Medium
$V \leq$ 0,4	Less

Source**:** (Retnowati, 2016)

Furthermore, the practicality test uses a practicality sheet that uses a Likert scale. Each statement is equipped with four answer options with the interpretation of strongly agree = 4, agree = 3, disagree = 2, strongly disagree = 1. The aspects and indicators used are presented in the following table.

Table 3. Aspects of practicality test

No.	Aspect Assessment	Number of Statements
1	Display of Teaching Materials	10
2	Presentation of Material	9
3	Learning	9
4	Benefits	5
Total Number of Statements		33

Source: *Researcher Data*

The results of the practicality test were analyzed quantitatively using the formula stated by (Lestari & Yudhanegara, 2015) as follows:

$$P = \frac{f}{n} x\ 100\%$$

Formula Description:
P = percentage of answer
f = Frequency of answer
n = Number of respondents

Furthermore, the percentage of practicality test results that have been obtained is interpreted using the following criteria:

Table 4. Criteria for interpreting the practicality of teaching materials

Percentage	Interpretation Criteria
P = 0%	None of the subjects considered the teaching materials to be practical
0% < P < 25%	A small proportion of the total Number of subjects considered the teaching materials to be practical
25% ≤ P < 50%	Almost half of the total Number of subjects considered the teaching materials to be practical
P = 50%	Half of the subjects considered the teaching materials to be practical
50% < P < 75%	Most of the subjects considered the teaching materials to be practical
75% ≤ P < 100%	Almost all of the subjects considered the teaching materials to be practical.
P = 100%	All subjects considered the teaching materials to be practical

Source: (Lestari and Yudhanegara, 2015)

III. Results and Discussion

The This The activities carried out in this study consisted of 4 stages, namely the Define, Design, Development, and Dissemination stages.

1. Define Stage

Needs analysis and literature study are two activities that have been carried out at this stage. The needs analysis was carried out by distributing questionnaires to students with the aim of identifying student needs for teaching materials for ordinary differential equations. The questionnaire that the researcher has designed is then distributed to 33 students who are taking ordinary differential equations in the even semester of the 2022/2023 academic year through google form with the link: https://forms.gle/PP46LggvvfsuBhh97

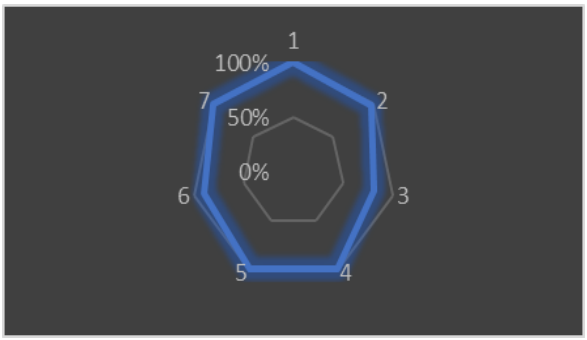


Figure 2. Percentage of student response to the need for teaching materials

Description

1 = Ordinary differential equations are an important important course
2 = Ordinary differential equations is a difficult course difficult course
3 = Reference in the form of ordinary differential equation books used, difficult to understand
4 = Learning ordinary differential equations should use teaching materials
5 = Teaching materials for ordinary differential equations teaching materials should be added
6 = Teaching materials for ordinary differential equations should enable us to work and cooperate and learn independently
7 = Teaching materials should be integrated with examples of problems and exercises that can train problem-solving skills and mathematical critical mathematical skills.

Figure 2 above informs that of the 7 statement items, there are 3 statements that get a percentage of 100%, namely statement numbers 1, 4, 5 and 7. This means that all students strongly agree with the statements given. While statements number 2, 3, and 6 get a percentage of less than 100%, namely 97%, 81.30% and 90.30%.

In addition to the quantitative data above, researchers also tried to dig further by asking the research subjects, which can be seen in the table below.

Table 5. Question items and student responses

No.	Question	Student Responses
1	Why are ordinary differential equations important to you?	There are respondents who stated that ordinary differential equations are closely related to other mathematical materials and can be used to solve everyday problems. There are also respondents who stated that learning ordinary differential equations can train their mathematical skills. However, some respondents do not know why ordinary differential equations are important to learn
2	Why have you had difficulty understanding the reference in the form of an Ordinary Differential Equations Book? Explain what you think is the reason.	Some respondents stated that the references to ordinary differential equations that had been owned and studied had language that was difficult to understand, too rigid, and used symbols that were not explained. Some respondents stated that the explanation of the material was too brief and to the point, the example problems were too few, while the exercises were different from the example problems presented
3	What is the most difficult material to understand from the Ordinary Differential Equations course?	Most respondents stated that homogeneous, nonhomogeneous, exact, and non-exact differential equations were the most difficult. However, some respondents stated that all the material presented in the ordinary differential equations course was difficult.
4	What solutions can be done by lecturers to make the Ordinary Differential Equations course easy to understand?	Responses stated that lecturers should explain the material in detail and not quickly. There are also respondents who stated that learning should be integrated with models or strategies that can stimulate activeness. There are also respondents who stated that lecturers should design teaching materials tailored to the needs of students. There are also respondents who stated that it is better to give more examples of solving the questions.

Based on the data presented in Figure 1 and Table 5 above, students have difficulty learning ordinary differential equations and need teaching materials integrated with active learning and mathematical abilities.

Furthermore, the researchers conducted a literature study by reviewing study materials, semester learning plans, and several related book references. From the literature study review results, researchers can state some of the material that will be presented in teaching materials, including understanding, order, and degree of differential equations, the formation of differential equations, and solving differential equations.

2. Design Stage

At this stage, the activities carried out consisted of several stages, namely:

a. Preparation of teaching materials

At this stage, a review and discussion were carried out with the research team regarding the material to be presented in the teaching materials. The learning objectives developed in the teaching materials will be presented in the table below.

Table 6. Learning objectives

Teaching Materials	Learning Objectives
1	Students can correctly explain the meaning of differential equations through learning Wankat and Oreovocz Strategies.
	Students can correctly identify ordinary, partial, linear, and nonlinear differential equations through learning from Wankat and Oreovocz Strategies.
	Students can correctly explain and identify the order and degree of differential equations through Wankat and Oreovocz Strategies learning.
2	Students can correctly determine the differential equation of the given equation through learning Wankat and Oreovocz Strategies.
3	Students are able to determine the solution of differential equations through learning Wankat and Oreovocz Strategies correctly.

Source: *Researcher processed data*

b. Application of Wankat and Oreovocz problem-solving strategies in teaching materials

At this stage, a review of the Wankat and Oreovocz Problem Solving Strategies that will be presented in teaching materials was conducted. Based on the results of the review, it was concluded that the Wankat and Oreovocz Problem-Solving Strategies steps in teaching materials would be presented with activities, namely: Let's I can, Let's identify (define), Let's state the question (explore), Let's make a plan (plan), Let's state the solution (do it), Let's check (check) and Let's state the conclusion (generalize). At the same time, the ability to solve mathematical problems that appear in sample problems and exercises in teaching materials consists of indicators: Identifying the sufficiency of data for problem-solving, Selecting and applying strategies to solve mathematical or non-mathematical problems, and Explaining and interpreting results.

c. Draft of teaching materials

At this stage, a draft of teaching materials is made in accordance with the material, model, and abilities that will be integrated. The following will present a snippet of the draft teaching materials for derivative materials with Wankat and Oreovocz Problem-Solving Strategies oriented to mathematical problem-solving skills.

LEMBAR AKTIVITAS MAHASISWA (LAM) – 1

PETUNJUK PENGGUNAAN BAHAN AJAR BAGI MAHASISWA

1. Bacalah lembar aktivitas mahasiswa ini dengan seksama, mulai dari petunjuk penggunaan sampai kepada latihan yang disajikan.
2. Pahami tujuan pembelajaran yang disajikan dalam lebar aktivitas mahasiswa ini agar memperoleh manfaat setelah mempelajari materi yang disajikan dalam lembar aktivitas mahasiswa ini.
3. Pelajari dengan baik materi, kegiatan pembelajaran, contoh soal, rangkuman dan latihan yang disajikan dalam lembar aktivitas mahasiswa ini melalui melakukan diskusi kelompok, jika terdapat informasi yang kurang jelas dan kurang dipahami atau mengalami kesulitan, silakan lakukan konsultasi dengan pengajar.
4. Pahami aktivitas pembelajaran yang disajikan dalam lembar aktivitas mahasiswa ini *yaitu I can, define, explore, plan, do it, check* dan *generalize* melalui diskusi kelompok, jika ada aktivitas pembelajaran yang belum dipahami silakan lakukan konsultasi dengan pengajar.
5. Pahami contoh soal beserta alternatif selesaian yang disajikan dalam lembar aktivitas mahasiswa ini melalui diskusi kelompok, jika ada yang kurang dipahami silakan lakukan konsultasi

TUJUAN PEMBELAJARAN

Setelah belajar menggunakan lembar aktivitas mahasiswa ini diharapkan:

1. Mahasiswa mampu menjelaskan pengertian persamaan diferensial melalui pembelajaran *Wankat and Oreovocz Strategies* dengan benar.
2. Mahasiswa mampu mengidentifikasi persamaan diferensial biasa, parsial, linier dan nonlinier melalui pembelajaran *Wankat and Oreovocz Strategies* dengan benar.
3. Mahasisa mampu menjelaskan orde dan derajat persamaan diferensial melalui pembelajaran *Wankat and Oreovocz Strategies* dengan benar.
4. Mahasiswa mampu mengidentifikasi orde dan derajat persamaan diferensial melalui pembelajaran *Wankat and Oreovocz Strategies* dengan benar.

PENJELASAN WANKAT AND OREOVOCZ STRATEGIES

I can	tahapan membangkitkan motivasi, membangunkan dan menumbukan keyakinan diri peserta didik
Define	Membuat daftar hal yang diketahui, ditanya, hal yang tidak diketahui, dan menggunakan gambar atau pemetaan pemikiran untuk memperjelas masalah

Ayo.....Saya Bisa (*I can*)

Dalam kehidupan sehari – hari, penggunaan persamaan diferensial sering ditemukan dalam permasalahan yang berasal dari fisika, kimia, teknik, ekonomi dan lainya yang penyelesaiannya menghasilkan model matematika. Model matematika yang terbentuk dapat dinamakan sebagai persamaan diferensial.

Tentunya jika kita tidak mengenal apa itu persamaan diferensial dengan baik, kita diasumsikan tidak akan dapat menyelesaikan permasalahan yang kita hadapi. Untuk itu, agar **kita bisa** menyelesaikan permasalahan di bidang fisika, kimia, teknik, ekonomi dan lainnya, ayo perhatikan dan pahami dengan sebaik mungkin penjelasan terkait persamaan diferensial di bawah ini.

Persamaan yang melibatkan turunan fungsi dari satu atau lebih peubah tak bebas terhadap satu atau lebih peubah bebas dapat disebut sebagai persamaan diferensial. Persamaan diferensial yang merupakan

Ayo.....Lakukan Identifikasi (*Define*)

Untuk dapat lebih memahami paparan materi pada tahapan ***Ayo Saya Bisa*** di atas, perhatikan pernyataan di bawah ini.

Berikut diberikan beberapa persamaan

a. $\frac{dy}{dx} = 3x + 7$

b. $\frac{d^2y}{dx^2} + 5\frac{dy}{dx} + 3y = 0$

c. $\frac{d^3y}{dx^3} + x^3\frac{d^2y}{dx^2} + x^2\frac{dy}{dx} = xe^x$

d. $\frac{\partial^3 z}{\partial x^3} + \frac{\partial^3 z}{\partial y^3} = x^2 + y$

e. $\frac{\partial y}{\partial s} + \frac{\partial y}{\partial t} = 0$

Ayo.....Nyatakan Pertanyaan (*Explore*)

Pada tahap **Ayo Lakukan Identifikasi**, ayo kita coba ajukan beberapa pertanyaan. Sebelum kita mengajukan pertanyaan, pastikan terlebih dahulu bahwa pertanyaan yang kita ajukan sesuai dengan penjelasan materi yang telah disampaikan dan kita pelajari pada tahap **Ayo Saya Bisa.**

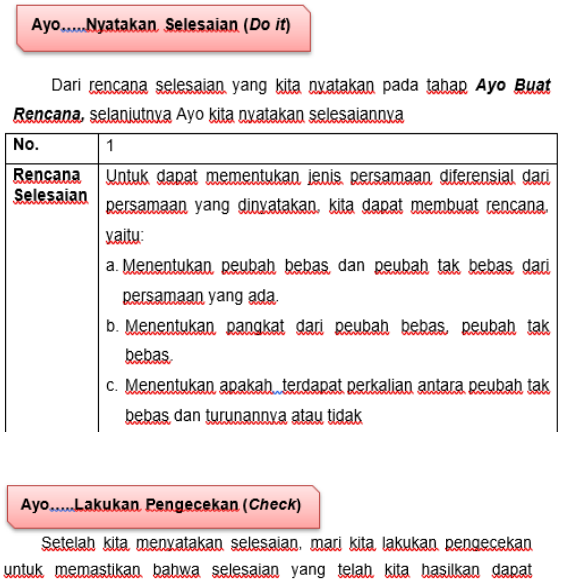
Contoh Pertanyaan yang bisa diajukan :

Komponen yang ditanyakan	**Draf Pertanyaan**
Jenis Persamaan Diferensial	**Alternatif Pertanyaan**: Tentukan jenis persamaan diferensial dari persamaan yang dinyatakan di bawah ini dengan disertai alasan! a. $\frac{dy}{dx} = 3x + 7$ b. $\frac{d^2y}{dx^2} + 5\frac{dy}{dx} + 3y = 0$ c. $\frac{d^3y}{dx^3} + x^3\frac{d^2y}{dx^2} + x^2\frac{dy}{dx} = xe^x$

Ayo.....Buat Rencana (*Plan*)

Untuk dapat menjawab pertanyaan yang telah kita ajukan pada tahap ***Ayo Nyatakan Pertanyaan*** di atas, Ayo kita buat rencana penyelesaiannya

Draf Pertanyaan	**Rencana Selesaian**
Tentukan jenis persamaan diferensial dari persamaan yang dinyatakan di bawah ini dengan disertai alasan! a. $\frac{dy}{dx} = 3x + 7$ b. $\frac{d^2y}{dx^2} + 5\frac{dy}{dx} + 3y = 0$ c. $\frac{d^3y}{dx^3} + x^3\frac{d^2y}{dx^2} + x^2\frac{dy}{dx} = xe^x$ d. $\frac{\partial^3 z}{\partial x^3} + \frac{\partial^3 z}{\partial y^3} = x^2 + y$ e. $\frac{\partial y}{\partial s} + \frac{\partial y}{\partial t} = 0$	Untuk dapat mementukan jenis persamaan diferensial dari persamaan yang dinyatakan, kita dapat membuat rencana, yaitu: a. Menentukan peubah bebas dan peubah tak bebas dari persamaan yang ada. b. Menentukan pangkat dari peubah bebas, peubah tak bebas. c. Menentukan apakah terdapat perkalian antara peubah tak bebas dan turunannya atau tidak d. Menentukan apakah terdapat fungsi transenden atau tidak pada peubah bebas tak bebas atau turunannya.



Ayo.....Nyatakan Selesaian (*Do it*)

Dari rencana selesaian yang kita nyatakan pada tahap ***Ayo Buat Rencana***, selanjutnya Ayo kita nyatakan selesaiannya

No.	1
Rencana Selesaian	Untuk dapat mementukan jenis persamaan diferensial dari persamaan yang dinyatakan, kita dapat membuat rencana, yaitu: a. Menentukan peubah bebas dan peubah tak bebas dari persamaan yang ada. b. Menentukan pangkat dari peubah bebas, peubah tak bebas. c. Menentukan apakah terdapat perkalian antara peubah tak bebas dan turunannya atau tidak

Ayo.....Lakukan Pengecekan (*Check*)

Setelah kita menyatakan selesaian, mari kita lakukan pengecekan untuk memastikan bahwa selesaian yang telah kita hasilkan dapat

Figure 3. Extract of teaching materials for ordinary differential equations with Wankat and Oreovocz problem-solving strategies

3. Development Stage

The draft teaching materials that have been designed will then be tested for validity. At this stage, the teaching materials were assessed by 3 expert validators. The validators consisted of 3 Mathematics Education Lecturers from the Faculty of Tarbiyah and Keguruan, Suska Riau State University. Validation was carried out from October 1-25, 2023.

The recapitulation of the teaching material validation results is presented in the figure below.

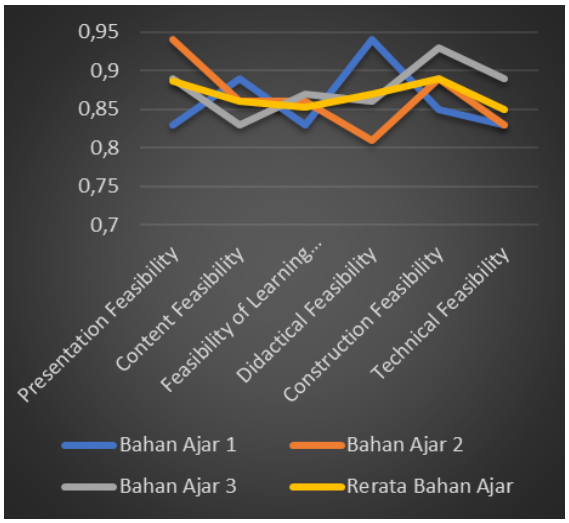


Figure 4. Teaching material validity test results

Based on the data presented in the figure above, teaching material 2 scores more excellently than teaching materials 1 and 3 in the presentation feasibility aspect. In the aspect of content feasibility, teaching material 1 has a score greater than the scores on teaching materials 2 and 3. The feasibility aspect of learning activities, teaching material 3 gets a score greater than teaching materials 1 and 2. Teaching material 3 gets a score greater than the scores on teaching materials 1 and 2 regarding didactical feasibility. Furthermore, regarding technical feasibility, teaching material 3 gets a score greater than the score of teaching materials 1 and 2. Overall, the average score on the presentation aspect and construction feasibility gets a greater score, while the smaller average score is in the aspect of feasibility of learning activities and technical feasibility. Overall, the score is very valid for each aspect of the teaching material.

From the results of the validation of teaching materials, one of the statements, "The description of Activities I can in teaching materials is in accordance with the meaning or explanation of the stages of Wankat and Oreovoct Strategy activities," which represents an indicator of conformity with Wankat and Oreovoct Strategies for the feasibility aspect of learning activities in teaching materials gets the lowest score of 0.74 with moderate validity criteria. Furthermore, the statement "The learning activities contained in this teaching material are suitable for increasing student group work activities" which represents an indicator of conformity with didactical requirements for the didactical feasibility aspect, and the statement "Teaching materials present a place to write answers for students that are sufficient" which represents an indicator of conformity with construction requirements for the construction feasibility aspect getting the highest score of 1 with very valid criteria.

Several suggestions and corrections from validators on the teaching materials have been developed and presented in the table below.

Table 7. Validators' suggestions for improvement of teaching materials

Corrected Part	Improvement Suggestion
Presentation aspect	No improvements or suggestions
Content feasibility aspect	- We should add an explanation regarding transcendent functions. - In GDP, there is no order or degree.
Learning activity feasibility aspect	- The I can activity should not only contain abstract words to present the definition. Relate it to everyday life. - The Define step should be more detailed so students can learn more independently.
Didactic feasibility aspect	A few mistakes are contained in the teaching materials, namely: $-\sin x + sinx = 0$; 0 = 0. Should be written $\frac{d^2y}{dx^2} + y = -\sin x = \sin x = 0$
Construction feasibility aspect	The column stating the answer is insufficient, so it should be presented more widely.
Technical feasibility aspect	More questions should be added.

Source**:** *Researcher processed data*

4. Desimination Stage

After the teaching materials were improved according to the suggestions and input from the validators, the next step was to test the teaching materials on the research subjects. Details of the trial implementation are presented in the table below.

Table 8. Trial implementation details implementation teaching materials

Day	Activity	Material
Monday, December 18, 2023	Pretest	Definition, order, and degree of differential equations, formation of differential equations, and solving differential equations
Friday, December 22, 2023	LAM 1	Definition, order, and degree of differential equations
Friday, December 29, 2023	LAM 2	Formation of differential equations
Friday, January 5, 2024	LAM 3	Solving differential equations
Monday, January 8, 2024	Posttest	Definition, order, and degree of differential equations, formation of differential equations, and solving differential equations

The implementation of learning by using teaching materials by the subject can be seen in the picture below.

Figure 5. Learning documentation

Learning using teaching materials is carried out by technical. First, the researcher opens the lesson and then explains the stages of learning by using teaching materials for ordinary differential equations based on Wankat and Oreovoct Strategies. Researchers divided students into several groups. Each group consists of 4 people. After students sat in their respective groups, researchers distributed teaching materials to be understood by students. The following is a snippet of students' answers to questions in the textbook.

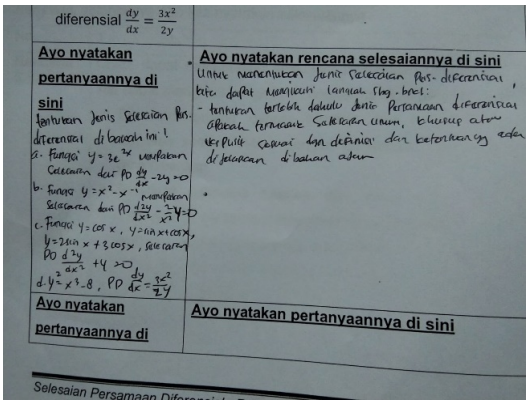


Figure 6: Snapshot of student response in learning

During learning by using this teaching material, students occasionally ask questions related to the activities in the teaching material with the aim of asking the purpose of the stages in the teaching material. However, overall, no urgent difficulties were found during learning. Based on the results of student work, there are still some problems that have not been resolved. After the researchers asked, it turned out that it was not because they did not understand but because the time available was not enough. That was the obstacle during this learning process.

At the last meeting, the researcher distributed the practicality test sheet to the research subjects. The recap of the practicality test results can be seen in the figure below.

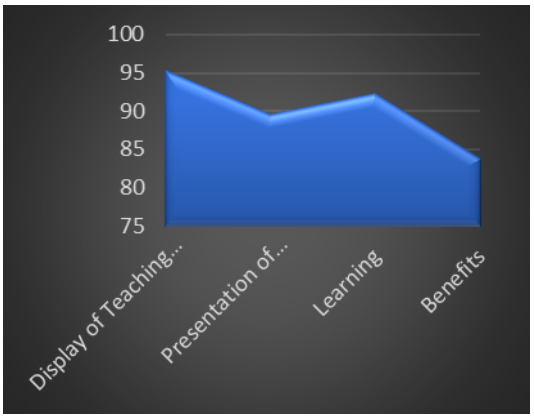


Figure 7. Practicality test results of teaching materials

Based on Figure 6 above, the benefits aspect gets the smallest percentage compared to other criteria. This benefit aspect consists of 5 statements. Of the five statements, the statement "I can work quickly in solving tasks and problems using this teaching material" gets the smallest percentage compared to other statements, which is 58% with the interpretation criteria that most subjects consider the teaching material practical. This means that there are still some students who consider this teaching material impractical.

This is in line with the researchers' findings conducted by interviews, namely, students feel that learning by using this teaching material requires more time. This means that students have been unable to work quickly to complete the tasks in this teaching material. This can be interpreted that teaching materials must be used according to their role, which can help students learn at their own pace (Magdalena, Sundari, Nurkamilah, Narullah, & Ayu Amalia, 2020).

Based on the results of the practicality test and the researchers' findings, it is necessary to think about improving teaching materials later to increase learning hours or reduce the number of questions and exercises contained in teaching materials for ordinary differential equations based on the Wankat and Oreovoct Strategy.

IV. Conclusion

The teaching materials developed received an assessment with a score of 0.9 or with very valid criteria. While 95% or almost all responses stated that the teaching materials used were very practical, it was still found that students could not learn quickly to solve tasks and problems using this teaching material. It is necessary to think about improving teaching materials later to increase learning hours or reduce the Number of questions and exercises contained in teaching materials for ordinary differential equations based on the Wankat and Oreovoct Strategy.

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