

REVOLUTIONIZING DERIVATIVE THEOREM LEARNING WITH MEME-BASED ELECTRONIC-STUDENT WORKSHEETS IN 11TH GRADE HIGH SCHOOL

Trophy Hutagalung^{1*}, Yatha Yuni², Rusdi Hamdany Nuary³

¹Agape BK3 Senior High School, Tangerang, Indonesia

^{2,3}Mathematics Education Study Program, STKIP Kusuma Negara, Jakarta, Indonesia

*trophy.hutagalung40@admin.sma.belajar.id

Abstract

Meme is mostly used in social media platform to know latest situation, therefore it is assumed that meme can also be used as a media to know mathematical concept. This research objectives are to develop meme-based electronic-student worksheet (E-SW) and to analyse its validity and effectivity in enhancing conceptual knowledge of derivative theorem. This is a Research and Development with mixed-methods analysis using ADDIE model. Subject of research are grade XI students of Agape BK3 Senior High School, and the object is their general conceptual knowledge. The object measurement is based on tests that passed analysis of question items. According to development result, meme-based E-SW is described as a valid media and granted to be applied in classroom by content experts and media experts. According to research result, there is correlation between multiple choice and essay formative test scores of 13 students in class XI A as group of experiment, and there is significant difference between essay formative test scores of students in class XI A and 17 students in class XI B as group of control based on post-test only result of true experiment. This research concludes meme-based E-SW is valid and proven enhancing conceptual knowledge of derivative theorem.

Keywords: conceptual knowledge, derivative theorem, meme-based Electronic-Student Worksheet.

1 INTRODUCTION

'Calculus is a major branch of mathematics which builds on algebra, trigonometry, and analytic geometry. It has widespread applications in science, engineering, and financial mathematics' (Robert Haese, et. al., 2012). As calculus has widespread applications, it is an important lesson in mathematics. Thus, in Indonesia it is always included in national curriculum for senior high school students. According to Minister of Education, calculus is divided into 3 subtopics: limit functions, derivative function, and integral function. With an attractive media of learning, delivered by a competent teacher, and in an interactive lesson activity, the test result is expected to be high.

However, the fact does not always meet the expectation. In Agape BK3 Senior High School Tangerang, researcher observed that from 2018 until 2024, average mere score of derivative function theorem formative test is below the Minimum Completeness Criteria (MCC). Similar trend has occurred nationally as Mathematics National Test mapping of calculus reported in 2019, the last year Nasional Test held (Sumaryanta, et. al., 2019). The analysis mentioned that current education system is not optimal yet.

Pandemic situation in 2020 aggravated education system as Government of Indonesia started to restrict school activity and applied online learning. Media of learning was also

adjusted. Student Worksheet (SW), in example, is transformed into Electronic-Student Worksheet (E-SW). While the uses of smartphone in education increased, many students apparently preferred to spend time watching social media instead of learning studies. Researcher observed through interactive-survey website Mentimeter that most of them spent 5 to 7 hours a day, scrolling social media like Tiktok or Reels. Similar trend was confirmed nationally by statistics-based website Katadata, with Instagram, Facebook, and Tiktok was on top 4 of the most seen social media in Indonesia per 2024.

Researcher also observed that many students watched contents in social media to know viral latest situations. Some of them would know viral situation from meme, since meme made fun of it. For example, there was news of a principal slapped a student who caught smoking in SMAN 1 Cimarga, Lebak, Banten. The student then told his mother and shortly they reported it to local police station. It soon went viral because most of netizens criticized governor's decision to deactivate the principal's job, referred it as obstruction to establish student's discipline. People made jokes of it with memes, as shown below:



Picture 1. Sample of SMAN 1 Cimarga Memes

According to comment section on a meme in social media, netizens who do not know about the context will ask the others to explain it so that they can enjoy the jokes as well. At this point, researcher assumed that meme can be applied to studies, mathematics in particular. Thus, when a mathematics meme is given, students will learn the mathematical concept to find its meaning and its jokes as well.

Research of meme uses in studies is already done by a few scholars in Universitas Muhammadiyah Prof. Dr. Hamka (Uhamka). They researched meme as media learning of history (Suswandari, et. al., 2020). Their research conclusion is relevant to this research. Firstly, most of meme readers are millennials, who are related to 11th graders in this research. Secondly, teacher is expected to help students to understand context of memes related to the lesson, in this research it refers to uses of meme-based E-SW in classroom. Thirdly, meme can be used as a media that increase student attention, in this research refer to the design of meme-based E-SW is made as attractive yet related to students.

Mathematics memes can be found in many social media accounts nowadays, however research of their impact in classroom is not available yet in Google Scholar website. Thus, this research is a novelty in Indonesia, and this meme-based E-SW can be a breakthrough for students in SMA Agape BK3 Tangerang to learn mathematics, derivative theorem in particular.

There are three questions that must be answered regarding development of meme-based E-SW. Firstly, can the meme-based E-SW be validated as a media to help students understand conceptual knowledge of derivative theorem? Secondly, do students in class XI A have their derivative theorem conceptual test result increased according to meme-

based E-SW uses in classroom? And thirdly, is there significant difference of test result between students in class XI A who use meme-based E-SW in classroom and students in class XI B who do not use it?

2 RESEARCH METHODS

This research held in Agape BK3 Senior High School Tangerang, located in Jalan Kebon Jahe Nomor 2, Kelurahan Sukarasa, Kecamatan Tangerang, Kota Tangerang, Provinsi Banten. Subject of research is 11 students in class XII A, 13 students in class XI A, and 17 students in class XI B, while the first object of research (as dependent variable) is validation of meme-based E-SW and the second object is participants general conceptual knowledge of derivative theorem based on tests (Anderson dan Krathwohl, 2010). Subjects are divided into 3 groups. Students in class XII A are subject in analysis of question items (difficulty level, validity, and reliability). All valid question items will be used in both form of tests, multiple choices and essay. Based on post-test only of true experiment (Yuwanto, 2019), students in class XI A are subject in experiment group who use meme-based E-SW in classroom, and students in class XI B are subject in control group who do not use meme-based E-SW in classroom. The research period is within 4 weeks, according to lesson's time allocation of derivative theorem in Agape BK3 Senior High School Tangerang.

The research and development are conducted based on level 4 (Sugiyono, 2019), which is to develop a meme-based E-SW and to test it in classroom so that its impact in enhancing conceptual knowledge of derivative theorem can be analysed. Data analysis is exploratory sequential mixed-methods (Sanjaya, 2021), divided to qualitative analysis of meme-based E-SW development through experts' validation questionnaires for research hypothesis (Yusrizal dan Rahmati, 2022), and quantitative analysis of meme-based E-SW uses in classroom through experiment's data tests with parametric statistics for statistic hypothesis (Sappaile, 2017). The taxonomy model used is ADDIE (Rusdi, 2018), which is acronym of its each process. The model is adjusted to the mixed-methods analysis of meme-based E-SW, as shown in table below:

Table 1. Research Model Description

Table 1: Research Model Description				
R&D Level 4 Smaller Stage	Smaller Stage Description	R&D Level 4 Main Stage	ADDIE Model	Data Analysis
Stage 1	Preliminary Analysis	Development	A	Qualitative
Stage 2	Meme-based E-SW Design		D	
Stage 3	Instruments Preparation		D	
Stage 4	Internal Test (Experts Validation)			
Stage 5	Evaluation and Research Hypothesis			
Stage 6	External Test (Uses in Classroom)	Research	I	Quantitative
Stage 7	Evaluation and Statistic Hypothesis		E	

3 RESULT AND DISCUSSION

3.1 Product Development Result

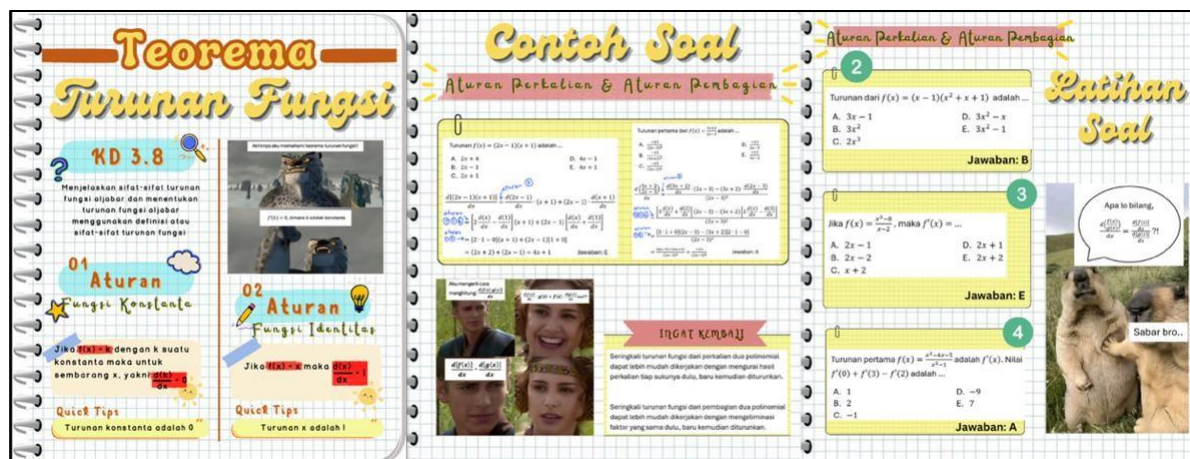
At the Analysis stage of ADDIE, the researcher conducted interviews about the needs for engaging learning media with all students of class XII A who had studied the material on the derivative theorem of functions, while showing several examples of derivative theorem memes. In general, their responses showed interest in these memes, especially memes created based on common mistakes in solving problems related to the derivative theorem of functions. Based on the interview results, the development of the meme-based E-SW could proceed to the next stage.

At the Design stage of ADDIE, the researcher created various memes about the derivative theorem of functions, including those related to the concept of the derivative theorem, general knowledge about derivatives, guidance on mathematical operations in derivative theorem, and common errors in solving derivative theorem problems. An example of each type of meme are presented in the following image:



Picture 2. Sample of Each Type of Derivative Theorem Memes

Then, these memes were inserted into the E-SW, which already contained summaries of material, example questions, exercises, and tests for research data. The layout and visual design were arranged in such a way to avoid monotony, using simple yet accurate language. The result was a prototype of a meme-based E-SW on the derivative theorem ready for internal testing (expert validation). Examples of the meme-based E-SW prototype page layouts are presented in the following image:



Picture 3. Sample of Meme-Based E-SW Page Layouts

At the initial Development stage of ADDIE, researcher interviewed an expert from Mathematics Education Study Program at STKIP Kusuma Negara, regarding content of expert validation instrument. The expert advised researcher to develop content of instrument independently by consulting various literacy sources. Therefore, researcher prepared the expert validation instrument with specific adjustments to each point found in the reference book. The result was expert validation instruments for every content and media expert, each also including assessment of language aspects.

3.2 Qualitative Data Description

At the final Development stage of ADDIE, the meme-based E-SW of derivative theorem underwent prototype validation by several experts, from STKIP Kusuma Negara, UPH College, and SMA Agape BK3 Tangerang. The following is descriptions of the questionnaires data for validation from these two areas of expertise.

3.2.1 Content Expert Validation Questionnaires

The data processing results of the questionnaires filled out by two content experts. Based on median analysis, it showed an overall average score of 69 out of a maximum score of 80, with the criterion of 'very feasible' for trial. The details are as follows: in the 'Content' category, a score of 27.5 out of a maximum of 32 was obtained with the criterion 'very feasible' for trial; in the 'Meme Content' category, a score of 21 out of a maximum of 24 with the criterion 'very feasible' for trial; and in the 'Language' category, a score of 20.5 out of a maximum of 24 with the criterion 'very feasible' for trial.

3.2.2 Media Expert Validation Questionnaires

The data processing results of the questionnaires filled out by two media experts. Based on median analysis, it showed an overall average score of 74.5 out of a maximum score of 80, with the criterion 'very feasible' for trial. The details are as follows: in the 'Design' category, a score of 29 out of a maximum of 32 was obtained with the criterion 'very feasible' for trial; in the 'Layout' category, a score of 23 out of a maximum of 24 with the criterion 'very feasible' for trial; and in the 'Typography' category, a score of 22.5 out of a maximum of 24 with the criterion 'very feasible' for trial.

3.3 Quantitative Data Description

At the Implementation stage of ADDIE, the meme-based E-SW of the derivative theorem was trialled with all students of classes XII A, XI A, and XI B at SMA Agape BK3 Tangerang. The research data details are as follows.

3.3.1 Item Analysis

For the Multiple-Choice Test data, item analysis was performed including difficulty level, validity test using the Biserial Product Moment Pearson, and reliability test using Kuder-Richardson (KR-20). The results of Competency Test 1 showed a well-distributed difficulty level: 3 easy items, 5 moderate items, and 2 difficult items. Validity tests indicated that the calculated r values of all items were greater than the table r value, thus all items are valid. The reliability test showed an r_{ii} value of 0.898, categorized as very high reliability. For Competency Test 2, the difficulty distribution was similar: 3 easy, 5 moderate, and 2 difficult items. Validity tests showed all items were valid, and reliability was 0.894 (very high). For the Formative Test, difficulty distribution was also balanced: 3 easy, 5 moderate, and 2 difficult items, with all items valid and reliability at 0.909 (very high). These multiple-choice test data were obtained from trials on class XII A students who had studied the derivative theorem material and were assumed all to have passed. For the Essay Test data, item analysis included difficulty, validity using Product Moment Pearson, and reliability using Cronbach's Alpha. Difficulty levels were well-distributed (3 easy, 5 moderate, 2 difficult). Validity tests showed all items were valid, and reliability α was 0.953, indicating very high reliability.

3.3.2 Test Results

The validated and highly reliable questions were compiled into research instruments for experimental testing in the form of multiple-choice and essay tests to measure conceptual knowledge of the derivative theorem among all students of classes XI A and XI B. The first test result data is from the Multiple Choice Test. The average score for Competency Test 1 was 71.54, increasing to 76.92 in Competency Test 2, and further rising to 82.31 in the Formative Test. Similarly, the passing percentage (scores above MCC) rose from 53.85% in Competency Test 1 to 61.54% in Competency Test 2, and then to 76.92% in the Formative Test. This data was collected from class XI A students using the meme-based E-SW. The second test result data is from the Essay Test. The average formative test score in class XI A was 87.31, higher than class XI B's 66.47. The passing percentage in class XI A was 69.23%, also higher than class XI B's 23.53%.

3.4 Requirements Testing for Analysis

At the early Evaluation stage of ADDIE, the uses result of meme-based E-SW of derivative theorem underwent data analysis requirements testing as follows.

3.4.1 Normality Test

The Essay Test data from class XI A were tested for normality using the Liliefors test. The test statistic obtained value of Z was 0.224, while the table value of Z was 0.234. Because the test statistic was less than the table value of Z , the formative test scores in class XI A were normally distributed. For class XI B Essay Test data, the Liliefors test yielded a value of Z was 0.166 against table value of Z was 0.206. Since the test statistic was less than the table value of Z , the scores in class XI B were also normally distributed. Therefore, both data sets can be analyzed parametrically.

3.4.2 Homogeneity Test

Next, homogeneity testing on the Essay Test data from both classes was conducted using the F test. The calculated F value was 1.30, while the table F value was 2.60. Since the calculated F was less than the table F , the formative test scores from both classes were homogeneous.

3.5 Hypothesis Testing

At the final Evaluation stage of ADDIE, statistical hypothesis testing of the meme-based E-SW was conducted as follows:

3.5.1 Associative Hypothesis Test

Based on the formative test data in the form of Multiple Choice and Essay Tests in class XI A using the meme-based E-SW, the Spearman Rank test was performed. The calculated ρ was 0.853, while the table ρ was 0.521. Since the calculated ρ was greater than the table ρ , H_0 was rejected and H_a accepted, meaning there was a correlation between the Multiple Choice and Essay Test scores. Although the Multiple-Choice Test results cannot be analysed using parametric statistics, they are consistent with the Essay Test results, which can be analysed parametrically. Therefore, the Essay Test indirectly indicates an increase in students' conceptual knowledge during uses of the meme-based E-SW in classroom.

3.5.2 Comparative Hypothesis Test

Furthermore, based on the formative test data in the form of Essay Tests from both classes, a t -test was conducted. The calculated t value was 4.162, while the average table t value was 1.764. This result was obtained using the t -test formula for two homogeneous samples. Since the calculated t was greater than the table t , H_0 was rejected and H_a accepted, indicating a significant difference between the formative test scores of class XI A, which used the meme-based E-SW, and class XI B, which did not.

4 CONCLUSION

A media can influence students' learning outcomes. The meme-based electronic student worksheet (E-SW) of derivative theorem is a revolutionary and breakthrough experienced by 11th-grade students at Agape BK3 Senior High School Tangerang. In accordance with academic procedures, the development and research of this meme-integrated E-SW followed several stages based on the ADDIE model.

According to academic procedures, the development of the meme-based E-SW must go through several stages. It begins with the visual and layout design process of the learning material summary, using language that is simple yet accurate, accompanied by example problems with solutions, practice questions, and meme content that contains humour while remaining relevant, resulting in a prototype ready for testing. The next stage involves preparing expert validation instruments to assess the prototype's feasibility intuitively, based on the experts' experience. The validation results showed that the prototype was highly feasible for trial, with excellent ratings in every assessment aspect. Thus, the prototype meets the requirements as a valid media of learning.

Further, item analysis was conducted in class XII A to determine which test items were valid and how reliable the test was as a research instrument. The meme-based E-SW was then used in the teaching and learning process in class XI A (experimental group) over three sessions. The analysis of the multiple-choice test pass-percentage in each session indicated an improvement in conceptual understanding. On the third session, an essay test was also administered in both class XI A and class XI B (as the control group). The data analysis showed consistency between the multiple-choice and essay test scores, explicitly indicating that students who used the meme-based E-SW in classroom already have good conceptual knowledge. This finding is further supported by additional data analysis, which revealed a significant difference, with the average score of class XI A being higher than that of class XI B. This implicitly suggests that the use of the meme-based E-SW improves students' conceptual understanding, compared to students who used a different E-SW.

This study has several limitations, including the absence of a language expert in the qualitative analysis and the use of a post-test-only experimental design in the quantitative analysis. However, since no scientific principles were violated at all, the results of this study remain fully accountable.

Based on the overall discussion, it can be concluded that the meme-based E-SW is a validated media of learning suitable for use in the teaching and learning process and is proven to enhance students' conceptual understanding of the derivative theorem.

This meme-based E-SW on the function derivative theorem can be utilized by Mathematics teachers as a media of learning to improve students' conceptual knowledge, as well as a humorous yet cognitively stimulating learning reference.

5 REFERENCES

- Anderson, Lorin W., dan David R. Krathwohl. Kerangka Landasan untuk Pembelajaran, Pengajaran, dan Asesmen. 2010. Yogyakarta: Pustaka Pelajar
- Haese, Robert, Sandra Haese, Michael Haese, Marjut Mäenpää, Mark Humphries. Mathematics for the Jakarta Student – Mathematics SL Third Edition. 2012. Adelaide: Haese Mathematics.
- Rusdi, M. Penelitian Desain dan Pengembangan Kependidikan: Konsep, Prosedur, dan Sintesis Pengetahuan Baru. 2018. Depok: Rajawali Pers.
- Sanjaya, Wina. Penelitian Pendidikan: Jenis, Metode, dan Prosedur. 2021. Jakarta: Kencana.
- Sappaile, Nursiah. Evaluasi Proses Pembelajaran dan Remediasi Belajar Matematika. 2017. Jakarta: STKIP Kusuma Negara.

- Sugiyono. Metode Penelitian & Pengembangan (Research and Development). 2022. Bandung: Alfabeta.
- Sumaryanta, Nanang Priatna, dan Sugiman. Pemetaan Hasil Ujian Nasional Matematika. Indonesian Digital Journal of Mathematics and Education, Volume 6 Nomor 1 Bulan Juli Tahun 2019. [https://staffnew.uny.ac.id/upload/131930135/penelitian/35.%20Sugiman2019 Pemetaan.pdf](https://staffnew.uny.ac.id/upload/131930135/penelitian/35.%20Sugiman2019%20Pemetaan.pdf)
- Suswandari, Nur Fajar Absor, dan Mohammad Badrus Soleh. Meme Sebagai Media Pembelajaran Sejarah Dalam Entitas Kebudayaan Masyarakat Milenial. Laporan Penelitian Kolaboratif Dosen dan Mahasiswa (PKDM). 2020. <https://simakip.uhamka.ac.id/download?type=penelitianlaporan&id=736&no=1>
- Yusrizal, dan Rahmati. Pengembangan Instrumen Afektif & Kuesioner. 2022. Sleman: Pale Media Prima.
- Yuwanto, Listyo. Pengantar Metode Penelitian Eksperimen Edisi 2. 2019. Yogyakarta: Graha Ilmu.