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Development of Online Biology Learning Media on Genetic Substance and Cell Division Material for Third Grade (XII) Methodist High School El Shadday Perbaungan

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Abstract

The objectives of this study were as follows: (1) To develop online learning media products on Genetic Substance and Cell Division through feasibility and validity tests by material and media experts certifying that this biology learning media is suitable for use in the field; and (2) To determine whether or not the utilization of online learning media influences student learning outcomes through more active and comprehensive engagement, as determined by data analysis following the execution of the learning process. The learning outcomes of students are influenced by the level of effectiveness of online learning media pertaining to Genetic Substance and Cell Division, as measured by the Gain Score. The field trial successfully fulfilled the effectiveness criteria; therefore, it can be inferred that the developed online biology learning media pertaining to Genetic Substance and Cell Division has been utilized effectively and has the potential to enhance the academic performance of high school students in this subject matter. The research methodology is in accordance with Borg and Gall 's 4-D model, which comprises the following stages: determination or definition, design, development, and dissemination.

Keywords: *Genetic Substance and Cell Division; Learning Media Development; Online Biology Learning Media*

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INTRODUCTION

Presently, education is situated within the era of knowledge, characterized by an unprecedented surge in the acquisition of knowledge. Education is gaining importance in the twenty-first century to ensure that students have the ability to work and sustain using life skills, as well as to foster innovation and proficiency with technology and information media (Wijaya et al., 2016). Information and communication technology advancements have altered every aspect of human existence, including working, socializing, playing, and studying. As we transition into the twenty-first century, technological progress has permeated every facet of existence, including the realm of education. It is mandatory for lecturers and students, educators and students, and students and teachers to possess the capacity to both study and instruct in the twenty-first century. In this information era, students and educators must confront a variety of obstacles and prospects in order to thrive in the age of knowledge (Pratiwi & Aminah, 2019).

The advent of Industrial Revolution 4.0 necessitates that the majority of individuals recognize the significance of technology. Existing technology positively impacts life in numerous ways. The effective integration of technology into the learning process equips educators with supplementary valuable information to impart to students (Astuti & ASikin, 2019). Technology should help teachers identify more appealing educational materials to motivate students. Along with searching for educational materials, instructors can leverage modern technology to create engaging learning media. Students will learn more. Students can review instructor content anytime, anywhere. Certainly, it has enough infrastructure. Teaching students how to use technology for good is essential. Acording Suhermiati et al., (2015); Nurani et al., (2016b) argue that biology students must understand biological ideas. They argue that pupils must learn rather than memorize these concepts. The educator guides pupils to understand biological ideas as another learning objective.

The 2013 Curriculum states that understanding the role of DNA and RNA in protein synthesis is one of the key skills that students in class XII must possess. The research findings of Tsui & Treagust (2003) indicate that high school students may find the genetics content to be somewhat difficult to understand and contain a significant quantity of sophisticated vocabulary. Genetics by Booth & Garrett (2004) is a field that has experienced rapid advancements in understanding since the discovery of DNA's structure. Genetics (Shaw et al., 2007) Everyone should know about this fiercely disputed health topic. Rare learning tools and abstract genetics make comprehension difficult. Without current technology, tiny objects are hard to see, making genetics unclear. Genetics students must comprehend symbols and remember several statements, which might be tough. Ribosome structure, DNA, RNA, transcription, and translation cannot be examined without modern technologies. The same thing is also explained by Byrd (2000) further explained that students struggle to understand DNA structure since it requires a strong chemistry background.

In addition, Murni (2013); Nurani et al., (2016) claims that protein synthesis involves many biological stages, making direct measurements difficult. The subject is

abstract, full of foreign vocabulary, and hard to understand. Faculty can use media to explain protein synthesis to students and clear up any confusion. The practical application of learning media in the teaching and learning process is elucidated by Karo-karo & Rohani (2018), Who thinks learning media improves learning by clarifying messages and information. Every teaching and learning process needs learning media. To attain learning objectives, educators must employ instructional media effectively, especially when teaching complicated or abstract subjects like protein synthesis. Media aids learning. Media explains difficult things to kids. Biology Learning 70% KKM in Perbaungan Methodist High School's 2019–2022 learning objectives, although genetic substance and cell division fall short (53.41, 67.08, and 55.40%). Learning problem help needed. Different methods can fix education. Online interactive learning enables teachers talk to students. The benefit of learning media, according to Faradila & Aimah (2018), Concentrating educational content boosts effectiveness. Asyar (2002); Zahwa & Syafi'i, (2022) This media is unique and vital. Building Android-based learning media with various teaching models and complete tools and contents is difficult. Students benefit from teacher modeling. Tools, power presentations, competency testing, and interactive teacher videos. These elements enhance web presentations, encourage creativity, and simplify media use. Android-based mobile learning research show promise.

Aripin (2018) believes Android devices can engage students in learning activities and create new learning experiences. PCs and laptops cost more than mobile learning. More affordable than PCs, smartphones can display text, video, sound, animation, and more. Image resolution, battery life, and file format compatibility limit Android learning. This media is unique and vital. Android-based learning media with many teaching models and complete tools and materials is challenging to build. Learners benefit from teacher model. Interactive teacher videos, tools, power presentations, and competency exams. These components improve web presentations, inspire creativity, and simplify media use. Results from Android-based mobile learning studies are promising. Studies conducted by Aditya (2018); Khaidir (2020), Cahyono (2013); Kuswanto (2019); and Rahmawati & Mukminan (2017) Prove Android-based mobile learning increases biology, math, and chemistry comprehension. Prior study showed mobile learning works in secondary biology. This media is unique and vital. Building Android-based learning media with various teaching models and complete tools and contents is difficult. Students benefit from teacher modeling. Tools, power presentations, competency testing, and interactive teacher videos. These elements enhance web presentations, encourage creativity, and simplify media use. This thesis explores the design of online biology learning materials to improve high school biology student learning results.

METHOD

The research procedure outlined here pertains to the 4D iteration of the research and development method originally suggested by Borg and Gall. It comprises the following stages: information gathering and research, planning, initial product development and

field trials, major revisions, and product revisions. operational, field testing in operation, revision of the final product, distribution and implementation of the product (Sugiyono, 2015). Figure 1 illustrates the schematic representation and justification for the modifications implemented in the development model according to Thiagarajan (1974).

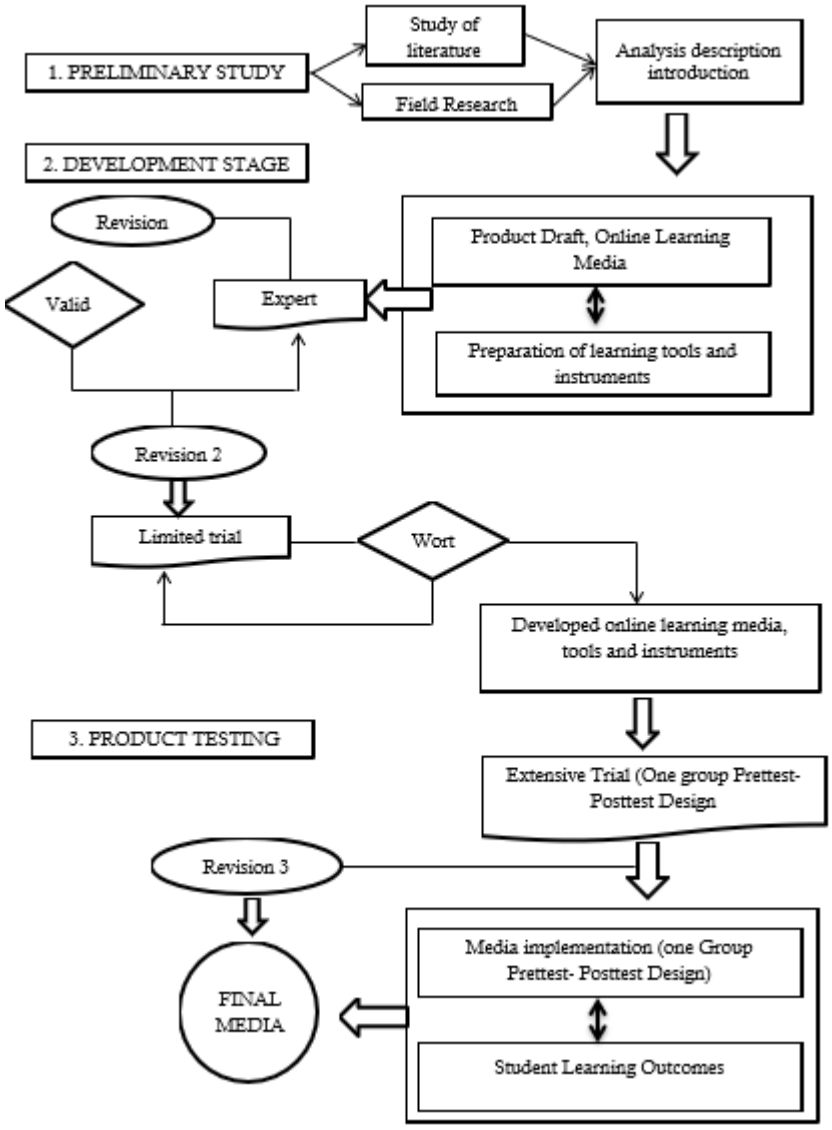

Figure 1. Research and Development Procedures (Arif & Muthoharoh, 2021)

Instruments

The instruments utilized in the creation of this non-textbook fall into two categories: those utilized for assessing feasibility and those utilized for evaluating the efficacy of the product. The instruments utilized in the feasibility test consist of a validation sheet, which is filled out with input, suggestions, and improvements concerning the non-textbook under development by each material expert, design expert, and language expert. Additionally, a questionnaire is employed to gather

responses from both teachers and students regarding the developed textbook. In contrast, the effectiveness test utilizes a pretest-posttest questionnaire to determine the learning outcomes of students subsequent to their utilization of the developed non-textbook.

Data analysis

Validation Questionnaire Data Analysis

Descriptive analysis was performed on the data obtained from the validation questionnaire, which pertained to the assessment of the feasibility of developing products for learning media. The criteria for determining validity level and product revisions are detailed in the table 1.

Table 1. Criteria for the level of validity of learning media by (Arikunto (2012)

Percentage(%)	Valid Criteria
76-100	Valid (no revision required)
56 – 75	Sufficiently Valid (no need for revision)
40 – 55	Invalid (revised)
0 – 39	Invalid (revision)

$$P = \frac{\Sigma X}{\Sigma Xi} \times 100\%$$

Where:

P = Percentage sought
ΣX = Number of Respondents' answers
ΣXi = Number of ideal values (number of highest values)

Analysis of effectiveness test data

The normalized gain test (N-Gain) was used to calculate the increase in students' cognitive learning outcomes utilizing the online learning resource Genetic Substance and Cell Division. The pre- and post-test comments from the pupils were the cause of this increase. This is called normalized gain, or N-Gain, because it compares the maximal and actual gain values (Hake, 1998). The maximum achievement score represents the highest possible achievement score that the pupil is capable of attaining, as opposed to the actual achievement score. As stated by Hake (1998); Sativa et al., (2022), the subsequent equation can be employed to compute the gain normality score (N-Gain):

$$< g >= \frac{< Sf > - < Si >}{100 - < Si >} \times 100\%$$

Information:

<g> = normalized gain (N-Gain)
<Sf> = Posttest Score
<Si> = Pretest Score

Table 2. Gain Normality Factor Criteria (N-Gain) by Sativa et al., (2022)

Gain factor (g)	Criteria
(g) > 0.7	Tall
0.3 ≤ (g)≤ 0.7	Currently
(g) < 0.3	Low

After calculating the N-Gain, a separate normalcy test and an independent t-test were performed. Finding out if the data distribution of a particular collection of variables or data follows a normal distribution is the goal of doing a normality test. After the data was classified as normal, an independent t-test was carried out. Two unpaired samples are evaluated differently by the independent t-test. Unpaired and paired samples are treated differently, but they are identical.

This study used the independent t-test to compare experimental and control group mean posttest scores of student learning outcomes. Compare the mean posttest scores of group B (experimental class) with group A (control class) for student learning outcomes. The t value and independent t-test were computed in this investigation utilizing IBM SPSS Statistics 27, with the t value serving as the basis *significance (Sig)* that is: If sig < 0.05, then Ho is rejected; If Sig > 0.05, then Ho is accepted

RESULTS AND DISCUSSION

Development and validation by material specialists, media experts, and biology teachers to make learning media for genetic compounds and cell division valid. This instructional media can be uploaded to Playstore and other digital social media. The following stage involved testing the learning material on 31 El-Shadday Methodist Private High School Third Level (XII) IPA-b students as an experimental class. Post-tests are given after using the produced learning media and pre-tests before using the application in the experimental class. The pretest-posttest test will reveal how using the designed learning media affects learning outcomes when testing online learning media.

The subsequent data illustrates the data processing of the trial results of the student learning outcomes test, which comprised twenty multiple-choice questions and involved twenty-five students from Third Level (XII) grade-IPA-a at El-Shadday Methodist Private High School,

Feasibility Test Results

Validity Test Results

Table 3. Validity Test Results

Number of questions	R Table	Average R-count	Criteria
40	0.396	0.562	Valid

Table 3 demonstrates that the learning outcomes of the 20 test questions that were tested yielded rcount values greater than rtable values, indicating their validity.

Difficulty Level Test Results

Table 4. Test Results Difficulty Level of questions

Test difficulty level criteria	Number of Questions	No. Question
Easy	21	1,6,7,9,10,11,12,15,17,18,23,25,26,29,30,31,35, 36,38,39,40,
Currently	13	2,3,4,5,8,13,14,19,20,21,22,33,37
Hard	6	16,24,27,28,32,34

The data reveals that out of the total of 40 questions, 21 were classified as easy, 13 as medium, and 6 as difficult in terms of difficulty level. The table 5 shows that as many as 40 learning outcomes test items have high criteria.

Difference Power Test Results

Table 5. Power Test Results are different

Number of questions	Average Rcount	Differential Power Value	Category
40	0.596	0.4 < D ≥0.7	Tall

Reliability Test

Table 6. Reliability Test Results

Number of questions	Average Rcount	rTable	Category
40	0.823	0.6 ≤ r11≤ 1.00	Tall

From table 6, the learning outcomes test is declared reliable with 0.6 ≤ r11≤ 1.00 (=0.823) so that the test can be used as a data collection test instrument. The reliability coefficient calculation yielded a value of 0.823, indicating that the dependability of the produced student learning outcomes exam falls into the "very high" category. This indicates that all the test items satisfy the requirements for reliability and are suitable for usage.

The Effectiveness Test of Online Learning Media Products

Assess the impact of educational media items on student learning outcomes by doing the N-Gain Score test with the use of Microsoft Excel 2010,

Table 7. Average N-Gain Score

Class		N	Mean	Std. Deviation	Std. Error Mean
Gain Score	Control Class	31	73.39	8,305	1,492
	Experimental Class	31	82.74	7,941	1,426

The analytical results presented in the table above indicate a disparity in the mean Gain Score between the experimental class and the control class. The experimental class has an average (mean) score of 82.74, whereas the control class has an average score of 73.39. Therefore, the experimental class outperforms the control class in terms of average score. To determine the efficacy of the treatment we administered, the post-test learning outcomes were measured as having T*value* > T*table* and P < 0.005. The table 8 displays an examination of student learning improvement using pretest, post-test, and N-Gain Score scores.

Table 8. Analysis Table for Improving Student Learning Outcomes

Control Class				Experimental Class			
Average Pre-test Score	**Average Post-test Score**	**G-Score**	**N-Gain**	**Average Pre-test Score**	**Average Post-test Score**	**G Score**	**N-Gain**
62.58	73.39	0.27	**Low**	56.29	93.06	0.84	**Tall**

The examination of research findings revealed that variations in N-Gain Score values were observed between the control and experimental groups. In contrast to the Control class, which obtained an N-Gain Score of 0.27 with low criteria, the experimental class achieved an N-Gain Score of 0.84 with high criteria. Based on the available data, it can be inferred that the utilization of developed learning media as instructional materials for students yields significant improvements in student learning outcomes.

Hypothesis Test

It is evident from the prerequisite tests that the data follows a normal distribution and possesses a homogeneous variance; therefore, we may proceed with the hypothesis testing. This is done in order to assess the learning outcomes of pupils subsequent to receiving a treatment.

Normality test

The purpose of conducting a normality test is to ascertain whether or not the data follows a normal distribution. The learning ability data from both the experimental and control classes were subjected to a normality test utilizing the Kolmogorov-Sminirnov Test method. Data is considered to follow a normal distribution when the probability value or sig. > 0.05. Table 9 presents the outcomes of the normality test conducted on the pupil learning outcomes.

Table 9. Normality Test Results of Student Learning Results Using SPSS 27

		Shapiro-Wilk		
Class		**Statistics**	**df**	**Sig.**
Results	Pre-Test (Control)	0.935	31	0.059
	Post-Test (Control)	0.897	31	0.006
	Pre-Test (Experiment)	0.947	31	0.133
	Post-Test (Experiment)	0.948	31	0.139

Lilliefors Significance Correction

A significant value was derived based on the outcomes of the Shapiro-Wilk normality test conducted with SPPS. sig value for experimental and control classes. > 0.05, The data on student learning outcomes can be characterized as having a normal distribution. Once the data has been normally distributed, the homogeneity test should be continued.

Homogenity Test

The purpose of conducting the data homogeneity test was to ascertain whether or not the sample group possessed identical abilities. The data homogenity test was conducted utilizing the SPSS 27 for Windows software with the assistance of Levene's Test. A condition for classifying data as homogeneous is when the probability value, denoted as sig > 0.05. The outcomes of the hypothesis testing on the data are presented in Table 10. Based on the sig. 0.070 > 0.05 obtained from the homogenity test results presented above, it can be inferred that the learning outcomes of the control class and experimental class are equivalent or homogeneous.

Table 10. Data Homogenity Test Results

		Levene Statistics	**df1**	**df2**	**Sig.**
Results	Based on Mean	3,405	1	60	0.070
	Based on Median	1,931	1	60	0.170
	Based on Median and with adjusted df	1,931	1	54,000	0.170
	Based on trimmed mean	3,530	1	60	0.065

Hypothesis testing may proceed once the conditions for the conducted data analysis, namely the normality and homogeneity of the data, have been met. The examination of hypotheses is conducted utilizing various techniques *Independent T-test* and the results are presented in Table 11 Independent T Test Results using SPSS. The aforementioned independent T test yielded a significance value of 0.00 (two-tailed) less than 0.05. It can be inferred that Ho has been denied in favor of Ha. Thus, it can be concluded that the experimental class achieves superior learning outcomes in comparison to the control class.

Table 11. Independent t-test test results

		Levene's Test (Equality of Variances)		T-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Results	Equal variances assumed	3,40	0.07	-10,99	60	0,00	-19,35	1,76	-22,87	-15,83
	Equal variances not assumed			-10,99	53,38	0,00	-19,35	1,76	-22,88	-15,82

Student Response

In order to assess students' reactions to the utilization of online learning resources pertaining to Genetic Substance and Cell Division content, a response questionnaire may be administered. The utilized questionnaire comprises three components: Interest, Material, and Language. It is evident from Table 12 that the mean percentage of results for each of the assessed indicators falls within the feasible category. This demonstrates that students react positively to online learning media.

Table 12. Student Responses to the Use of Online Learning Media

No.	Assessment Aspects	Assessment Indicators	Score	Percentage	Category
1	Interest	Attractive in appearance is the Android application.	333	89.52	Very Worth It
		Students are more interested in learning about genetic materials and cell division because of the show on the Android app.			
		I am learning more about genetic materials in cell division with the help of this Android app.			
2	Material Contents	By utilizing this Android application, pupils gain a deeper comprehension of genetic substances and cell division.	558	90.00	Very Worth It
		The information contained within this content is readily comprehensible to me.			
		Utilizing this educational resource teaches pupils to respond to inquiries.			

No.	Assessment Aspects	Assessment Indicators	Score	Percentage	Category
		The presentation of content in this media is engaging because to its incorporation of visually appealing graphics and vibrant colors.			
		Engaging with this medium fosters a sense of collaboration and cooperation with others.			
3	Language	The paragraphs and sentences utilized in this medium are concise and straightforward to comprehend.			
		The language employed in this media is straightforward and uncomplicated.	338	90.86	Very Worth It
		The used letters are straightforward and uncomplicated to read.			
Total Score			1229		
Percentage Score			90.1		
Category				**Very Worth It**	

Effectiveness Test Results-Student Learning Outcomes of Genetic Substance and Cell Division and Their Use

Prior to implementing the treatment, an analysis revealed that 31 students in the experimental group, who completed the pretest, obtained an average score of 56.29 with two passing the KKM based on incomplete criteria. In contrast, 31 students in the control group, who completed the pretest, obtained an average score of 62.58 with the criterion of failing the KKM. Eleven of the twenty candidates achieved scores in excess of the KKM. In the experimental class, learning was conducted through the utilization of online learning media that was both developed and tested. At the conclusion of the course, 31 students achieved an average score of 93.06, surpassing the KKM. The Control Class, comprising 31 students who utilized undeveloped media, achieved an average score of 73.39.

The completion criteria for this group were as follows: 9 students obtained an incomplete grade, meaning they did not surpass the KKM score; and 22 students attained a complete grade or surpassed the KKM score. Based on the findings of the subsequent comparison, it can be inferred that students who utilize biology learning media achieve comparatively superior results than those who rely on outdated, non-developed media. The t-test yields the significance value (sig). The value of 0.000 < 0.05, indicating a statistically significant difference between the experimental class and the control class. Another factor that can indicate the success of the treatment is to examine the gain score. The experimental class achieved a Gain Score of 0.84 based on the research data (N-Gain = High) and the control class had a Gain Score of 0.27 (N-Gain = Low).

CONCLUSION

The following are the conclusions that have been derived from the research and subsequent discourse: (1) Development of online learning media products on Genetic Substance and Cell Division material after material and media experts conduct feasibility and validity tests indicating that the learning media is suitable for use in the field; (2) Student learning outcomes are influenced through more active and communicative student learning activities, as determined by data analysis following the implementation of the learning process using online learning media; (3) The learning process is facilitated by the data analysis results. The learning outcomes of students are influenced by the level of effectiveness of online learning media pertaining to Genetic Substance and Cell Division, as measured by the Gain Score. The field trial successfully fulfilled the effectiveness criteria; therefore, it can be inferred that the developed online biology learning media pertaining to Genetic Substance and Cell Division has been utilized effectively and has the potential to enhance the academic performance of high school students in this subject matter.

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