

Article History

Received: 17/07/2023

Accepted: 12/11/2023

Published: 30/12/2023

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THE DEVELOPMENT OF STEM-BASED E-STUDENT WORKSHEETS ON ELECTROLYTE AND NON-ELECTROLYTE SOLUTION MATERIAL TO IMPROVE STUDENT'S LEARNING OUTCOMES

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Abstract

The aim of this research is to develop STEM-based E-Student Worksheets, determine the feasibility of STEM-based E-Student Worksheets as assessed by material expert validators, learning experts, and design experts, and describe the effectiveness of STEM-based E-Student Worksheets in improving student learning outcomes in the concept of electrolyte and non-electrolyte solutions. This Research and Development using the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation). Product trials were conducted on a small group of 30 students from a single class. Material experts, three learning experts, three design experts, and pre-test and post-test results were used to collect data, which was then analyzed and described. Validators declared that the e-worksheet is feasible to use in the learning process with successive average scores: 81.5%, 87.8%, and 85.9% with very feasible criteria and the STEM based E-Student Worksheets has effectively improved the student learning outcomes and can be used in the learning process. The average pre-test score was 51.67 while the post-test score average of 86.33 were obtained. The average N-Gain was significantly high at 0.72 with high interpretation and a percentage of completeness of 90%.

Keywords: *Development; STEM; E-Student Worksheets*

doi:10.24815/jcd.v11i2.33170



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INTRODUCTION

Indonesia continues to face a problem in improving the education quality. According to the 2003 PISA (Program for International Student Assessment) Study results, Indonesia was ranked 38th out of 41 participating countries in terms of science education quality. Science education is of poor quality in schools, which serve as the hub of educational delivery [1]. Based on observations made by researchers at Islamic High School (MAN) No. 1 Medan, it is revealed that the average results of the daily chemistry test for class X was far from the minimum completeness criteria (KKM), which was set to the minimum of 75%, partly due to students' less understanding of chemistry concepts. The 2013 curriculum demands that the learning process be carried out interactively, creatively, fun, and challenging, motivating students to be active in learning and providing ample space to hone their skills [2]

Every learning process is undoubtedly expected so that students get good learning outcomes. However, in reality, the learning outcomes obtained by students are not always good, and as expected as a good standard or not, learning outcomes based on KKM which has been set as a benchmark for the success of the learning process. It should be a concern and evaluation material in the learning process. Poor student learning outcomes are one of the problems in education. Student learning outcomes show the ability and quality of students as a result of the learning

process they have gone through [3]. To deal with the problem of students' learning outcomes by implementing an integrative approach during the learning process and applying it by linking the four fields of discipline (Science, Technology, Engineering, and Mathematics) to improve students' learning outcomes. STEM education is a "meta-discipline," which means "the creation of a discipline based on integrating other disciplines' knowledge into a new 'whole' rather than pieces. [4] - [6].

The researcher chose the STEM approach because STEM-based learning maximally involves students' ability to search for and find something systematically, logically, and analytically so that they can formulate their findings and be useful for their daily lives. [7] the research found that using the STEM-based learning model successfully improved chemistry learning outcomes in dynamic equilibrium material. According to [8] Learning by integrating STEM can significantly affect academic achievement. Through the STEM approach, students memorize concepts, how they understand scientific concepts, and their relation to everyday life.

According to observations in class X MAN 1 Medan, the teaching materials used by teachers during learning are less varied. Making student worksheets more interesting is one way to improve the quality of the learning process.

Student worksheets are one type of teaching material teachers can use in learning activities. Student

worksheets are usually presented in a printed form with instructions and study guides, as well as tasks to be done by students that have been adapted to the essential competencies and expected learning indicators [9]. As teaching materials, Student worksheets have four functions, including:

1. Can maximize student learning activities so that learning activities are student-centered.
2. They are helping students to learn and better understand the material being taught.
3. Student worksheets are presented more succinctly and richer in assignments as training material for students.
4. Student worksheets make it easier for teachers to provide subject matter to students [10].

The researchers explore further to provide innovation by developing E-Student Worksheets, which play a role in facilitating students and teachers when teaching and learning as the form of progress in the development of technology and information in the education world. Electronic Student Worksheets (E-Student Worksheets) are a series of activities used by students in conducting investigations and solving problems to make it easier for students to understand learning material in electronic form, the application of which uses desktop computers, notebooks, and smartphones [11].

E-Student Worksheets, according to [12], can simplify and narrow space and time to make learning a more effective learning resource. The chemistry learning process that has existed so far needs to be improved and designed in such a way as to provide attractive and fun learning conditions so that students are more enthusiastic, passionate, and interested in chemistry [13].

Based on these Student Worksheets issues, the author seeks to provide innovation by developing E-Student Worksheets that facilitate teaching and learning for students and teachers. This E-Student worksheet was created on a STEM basis to improve students' learning outcomes in electrolyte and non-electrolyte solution subjects in an appealing, logical, structured, and user-friendly format. The objectives of this research are to determine the development of STEM-Based E-Student Worksheets, its feasibility, and the improvement of students' learning outcomes in electrolyte and non-electrolyte solutions material. According to the National Standards Agency [14], several aspects must be present in the development of student worksheets which include: content feasibility aspects, linguistic aspects, presentation aspects, and graphical aspects.

METHOD

This research is research and development (R&D). The development model used in this study is the ADDIE development model. The ADDIE development model comprises five stages: analysis, design, development, implementation, and evaluation [15]. This research uses

the ADDIE model in the STEM-Based E-Student Worksheets development process. The ADDIE model is one of the most commonly used models in developing teaching materials to produce effective product designs [16].

This study produced a STEM-based student worksheet on electrolyte and non-electrolyte material. The ADDIE model was used by researchers during this stage of the study. The ADDIE model is a five-stage learning model that includes analysis, design, development, implementation, and evaluation.

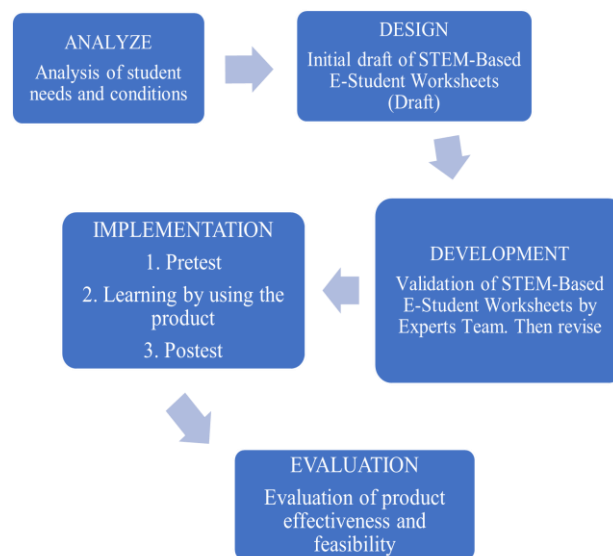


Figure 1. Stages of ADDIE Model

The population of this study was all students of class X MIA MAN 1 Medan, the research sample is one of the class X MIA. The data collection technique in this study was through observation, interview, the distribution of questionnaires to the validators (material experts, learning experts, and design experts), and test technique. All questionnaires from the material, learning, and design experts were collected, and the materials were analyzed according to a Likert scale, then analyzed. This study also collected data on student learning outcomes through pretest and posttest given to students. The data can be analyzed using the N-gain score (normalized gain) with the following equation:

$$N - \text{gain} = \frac{\text{Posttest Score} - \text{Pretest Score}}{\text{Max Score} - \text{Pretest Score}}$$

The improvement of learning outcomes are analyzed and then categorized into three categories. These categories can be seen in Table 1 [17], [18].

Table 1. N-Gain Criteria

No	Range	Criteria
1	$G > 0.70$	High
2	$0.30 - 0.70$	Medium
3	$0.00 - 0.29$	Low

RESULTS AND DISCUSSION

The results and discussion should be combined and should explore the significance of the results of the work, don't repeat them. Avoid extensive citations and discussion of published literature only, instead discuss recent literature for comparing your work to highlight the novelty of the work in view of recent development and challenges in the field.

Analysis Results

The needs analysis stage was carried out to see the needs of students in using learning tools, as well as the availability of learning tools that support the implementation of learning and the extent to which the teacher teaches Chemistry. the results are shown in Table 2.

Table 2. Table of Analysis Results

No.	Needs Analysis
1	Teachers still carry out conventional learning, so they cannot explore and improve students' understanding of chemistry.
2	The learning process relies greatly on the role of educators
3	Lack of enthusiasm of students in the process of learning
4	Low student learning outcomes.
5	The Internet facilities in schools is not optimally used
6	STEM-based E-Student Worksheets for Chemistry have not yet been developed so far

Design Results

This stage begins with determining the components of STEM-based E-Student Worksheets writing, and learning. At this stage, the Learning Plan is made according to the material that has been determined. Next, it is determined how the STEM-based E-Student Worksheets are designed. The contents of the E-Student Worksheets worksheets are designed according to competency standards, core competencies, and learning objectives contained in the 2013 Curriculum developed on a STEM basis.

STEM-based E-Student Worksheets are developed by completing the following components: cover, title, preface, table of contents, competencies that students must achieve (consisting of Core Competencies, Basic Competencies, indicators, learning objectives), instructions for using E-Student Worksheets (for teachers and students), a description of the STEM learning model, learning materials, activity units, and bibliography. The researcher used several applications during the design stage, including Office Word to compile and design the contents of the E-Student Worksheets so that they are neatly arranged; Canva to design attractive covers, headers, and footers; and researchers also used the Student Liveworksheets Website, which is a website that is used to create and design E-Student Worksheets to be interactive for the learning process.

Development Results

At this stage, the researcher developed the STEM-based E-Student Worksheets with Electrolyte and Non-Electrolyte Solution subjects to increase students' understanding of the material and improve student learning outcomes. At this stage, validation is also carried out on the E-Student Worksheets that have been developed. Material, learning, and design experts carried out the validation series. The validation results are used to determine the eligibility of the E-Student Worksheets.

After the E-Student Worksheets have been validated by three material experts, three learning experts, and three design experts, the results is depicted in Figure 2.

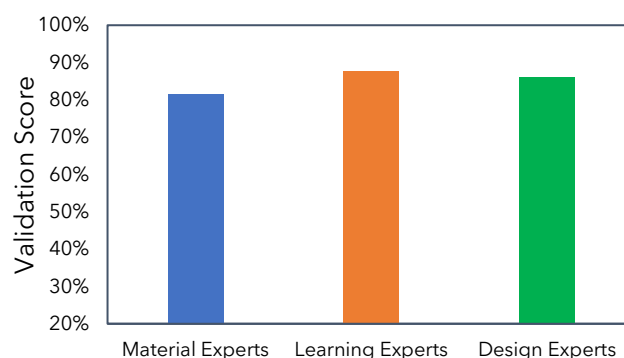


Figure 2. Analysis of Data Validation Results

Based on the Figure 2, we can see that according to material experts, the E-Student Worksheets had been validated declared "very valid" with a presentation score of 81.5% with very feasible criteria. According to learning experts the validated E-Student Worksheets are declared "very valid" with a presentation score of 87.78% with very feasible criteria. According to design experts, the validated E-Student Worksheets are declared "very valid" with a presentation score of 85.97% with very feasible criteria. After the material, learning, and design expert validators validated the STEM-BASED E-Student Worksheets, the experts provided some suggestions and improvements so that the STEM-BASED E-Student Worksheets could be even better.

Implementation Results

The E-Student Worksheets are then tested on a small group of students in the class after being validated by a team of experts. The goal of this study was to see how well E-Student Worksheets worked in terms of improving student learning outcomes.

The results of data analysis showed that the lowest pretest score was 40 while the highest pretest score was 70, with an average pretest score of 51.67. The lowest posttest score was 70 while the highest posttest score was 90, with an average posttest score of 86.33 with a completeness percentage of 90% and an N-Gain score of 0.72 with high criteria. Data analysis of students' pretest and posttest scores before and after using

STEM-based E-Student Worksheets on Electrolyte and Non-Electrolyte Solutions is presented in Table 3 below.

Table 3. Analysis of Pretest and Posttest Results

Centralization and data distribution	Pre-test	Post-test
Lowest Score	40	70
Highest Score	70	90
Mean	51.6	86.3
Standard Deviation	± 8.7	± 6.7
Classical completeness (%)	0	90

For a comparison of the results of the pretest and posttest, it can be seen in Figure 3.

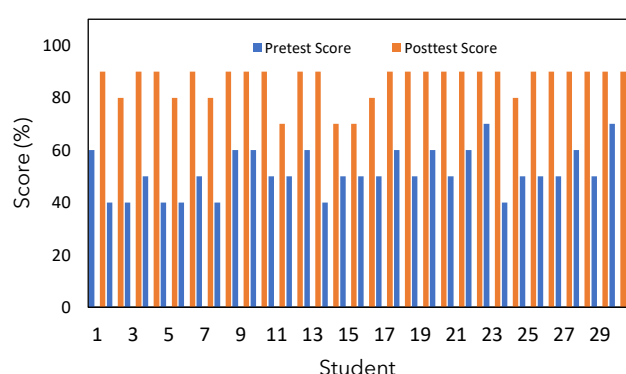


Figure 3. Comparison of Students' Pre-test and Post-test Results

It can be seen that there is a rapid development of student test results. This can also be proven by the N-Gain Test. The statistical data for the N-Gain Test relating to student learning outcomes in the material for Electrolyte and Non-Electrolyte Solutions are presented in Table 4.

Table 4. N-Gain Score Analysis

No	N-Gain Index	Criteria	Freq.	(%)	Mean
1	$g > 0.70$	High	21	70	0.72
2	0.30 – 0.70	Medium	9	30	
3	0.00 – 0.29	Low	0	0	
Total			30	100	

Based on Table 4 above, it was obtained that 21 students with a percentage of 70% obtained an N-Gain score with high criteria, and 9 students with a percentage of 30% obtained an N-Gain score with medium criteria. The overall N-Gain score of student learning outcomes on Electrolyte and Nonelectrolyte Solutions is 0.72, which can be interpreted as high with the classical completeness percentage of 90%.

CONCLUSION

Based on the research conducted on the development of ATEM-Based E-Student Worksheets on Electrolyte and Non-Electrolyte Solutions Material in Improving Students' Learning Outcomes conclusions can be drawn:

STEM-based E-Student Worksheets have been developed in the ADDIE development model which is implemented by integrating four fields of science, namely Science, Technology, Engineering, and Mathematics (STEM).

The results of the validity of STEM-based E-Student Worksheets with the aim of improving student learning outcomes STEM-based E-Student Worksheets assessed by nine expert lecturers consisting of three material expert validators, three learning expert validators, three design expert validators were declared very feasible to use in the learning process with successive average scores: 81.5%, 87.78% and 85.97% with very feasible criteria.

STEM-based E-Student Worksheets on electrolyte and non-electrolyte solution materials that have been designed and developed effectively to improve student learning outcomes and can be used in chemistry learning, with learning outcomes obtained an average pretest score of 51.67 and a posttest of 86.33 and an average N-Gain of 0.72 with a high interpretation and percentage of classical completeness of 90%.

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