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DEVELOPMENT OF E-HANDOUTS ACID-BASE MATERIALS IN HIGH SCHOOL USING THE SOROGAN LEARNING METHOD

M. Zaki Ghufron and Rinaningsih*

Department of Chemistry, FMNS, Universitas Negeri Surabaya

e-mail: rinaningsih@unesa.ac.id

Abstract

The Independent Curriculum encourages educators to create innovative, interactive, and student-centered learning processes, especially in chemistry lessons that contain many abstract concepts that often cause difficulties in understanding the material. One alternative that can be implemented is the development of e-handouts combined with the sorogan learning method so that students are more active and able to learn independently in understanding the learning material. This study aims to develop e-handouts on acid-base material using the sorogan learning method and to determine the level of validity, practicality, and effectiveness in improving student mastery of concepts. The method used in this study is Research and Development (R&D) which includes a preliminary study stage, media development, and limited trials with 28 high school students as research subjects. The research instruments consisted of validation sheets, student activity observation sheets, student response questionnaires, and pretests and posttests. The results showed that the developed e-handouts met the validity criteria based on content validity with mode 5 categorized as very valid and construct validity with mode 4 categorized as valid. The developed learning media is also considered practical based on the results of observations of student activities at 89% and student response questionnaires at 81%. In addition, the e-handout was declared effective in improving student conceptual mastery based on the N-Gain Score results with a medium category of 61% and a high category of 4%. Thus, the e-handout based on the sorogan learning method is able to help students understand acid-base concepts more independently, actively, and comprehensively. This research contributes to the development of digital-based chemistry learning media that can be used as an alternative innovative teaching material to support the implementation of the Independent Curriculum through more individualized, interactive, and effective learning.
Keywords: acid-base, chemistry learning, e-handout, learning outcomes, sorogan

INTRODUCTION

The Independent Curriculum positions students at the center of learning by providing flexible learning spaces that are oriented toward strengthening 21st-century competencies. Implementing this curriculum requires educators to deliver innovative learning and encourage active student engagement. In chemistry learning, many concepts are abstract, requiring open-ended materials that facilitate conceptual visualization and comprehension [1]. The development of digital teaching materials, such as e-handouts and e-modules, is considered to enhance student understanding through more interactive and systematic presentation [2]. Furthermore, the use of digital learning media has also been shown to improve student learning outcomes in chemistry [3]. Therefore, the implementation of e-handouts, combined with the sorogan learning method, is considered relevant to support more independent and individualized learning.

The need for innovation in science learning in Indonesia remains a concern because students' scientific literacy skills have not shown optimal results. The results of the 2022 Programme for International Student Assessment (PISA) showed that Indonesia's scientific literacy score reached only 383 points, still below the OECD average of 476 points. Furthermore, only around 34% of Indonesian students were able to achieve the minimum level of scientific competency, indicating still low abilities to understand scientific concepts and solve contextual problems [4]. This condition indicates that science learning requires

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more effective, student-centered media and strategies [5]. The use of digital-based e-handouts and the sorogan learning method is expected to support more adaptive and interactive chemistry learning and improve conceptual mastery in acid-base material.

Several previous studies have examined the development of e-handouts and the application of learning methods to improve the quality of learning. [6] demonstrated that the development of handouts on acid-base material using the sorogan learning method met the criteria of being very practical and effective in improving student learning outcomes. [7] found that the e-handout enrichment materials they developed had excellent validity and readability, making them suitable for use in high school learning. Furthermore, [8] stated that application-based e-handouts using a problem-based learning model can increase student engagement and understanding during the learning process.

Based on several previous studies, the development of e-handouts has been widely carried out on various learning materials, but research integrating e-handouts with the sorogan learning method on acid-base material is still limited. Previous studies also emphasized the validity and practicality of the media, while studies on the effectiveness of e-handouts in improving students' conceptual mastery have been suboptimal. Therefore, this study aims to develop e-handouts on acid-base material using the sorogan learning method and analyze their validity, practicality, and effectiveness in chemistry learning. This research is expected to provide an alternative, innovative digital teaching material, support the implementation of the Independent Curriculum, and help improve students' conceptual mastery of acid-base material.

METHOD

This study used a Research and Development (R&D) approach aimed at developing an e-handout on acid-base material using the sorogan learning method. The development model used consisted of three stages: preliminary study, media development, and limited trials. The study was conducted in a high school with eleventh-grade students studying acid-base material as the subjects. The research instruments used included a validation sheet, a student activity observation sheet, and a questionnaire. student responses, as well as pretests and posttests. Media validation was conducted by experts to determine the suitability of the e-handout based on content and construct aspects before it was implemented in learning.

Data collection techniques were carried out through observation methods, questionnaires, and learning outcome tests. Validity data were obtained from the results of the validator's assessment of the developed e-handout, while practicality data were obtained through observation of student activities and questionnaire responses during the learning process. Effectiveness data were obtained from the results of the pretest and posttest which were analyzed using the N-Gain value to determine the increase in student concept mastery after using the e-handout. The research data were analyzed descriptively quantitatively by interpreting the validation results scores, student responses, learning activities, and improvements in learning outcomes based on predetermined criteria.

RESULTS AND DISCUSSION

The results of the study showed that the e-handout on acid-base material with the sorogan learning method fulfilled the aspects of validity, practicality, and effectiveness in the chemistry learning process.

Table 1. E-Handout Validation Results

Assessment Aspect	Percentage (%)	Criteria
Content Validity	92	Very Valid
Construct Validity	94	Very Valid
Average	93	Very Valid

Table 1 shows the validation results of the e-handout based on content and construct validity aspects. The validator's assessment results indicate that the e-handout achieved a very high validity percentage in each assessment aspect. Content validity achieved a percentage of 92%, while construct validity achieved a percentage of 94%. These results indicate that the developed e-handout

is appropriate to the learning material and student characteristics, and has a systematic and easy-to-understand presentation, making it suitable for use in the learning process.

Figure 1. E-Handout Display of Acid-Base Material

Figure 1 shows the e-handout developed for the acid-base topic. The e-handout is designed digitally and includes a concept map, learning objectives, materials, sample questions, learning videos, and practice questions based on numeracy literacy. The presentation of the material, complemented by attractive images and colors, aims to increase student interest in learning and facilitate independent understanding of the acid-base concept through the sorogan learning method.

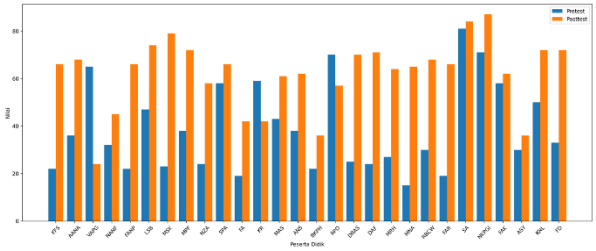

Figure 2. Graph of Student Pretest and Posttest Results

Based on Figure 2, the students' posttest results generally showed an improvement compared to their pretest scores. Most students obtained initial scores that were still in the incomplete category, but after using the e-handout with the sorogan learning method, the students' scores increased quite significantly. Improvements were seen in almost all students, such as MSK which increased from 23 to 79 and DAF which increased from 24 to 71. Although there were still some students who had not achieved completeness, the posttest results showed a change in conceptual understanding that was better than before the learning. These findings indicate that the use of e-handouts based on the sorogan method can help students improve their conceptual mastery of acid-base material more effectively and independently.

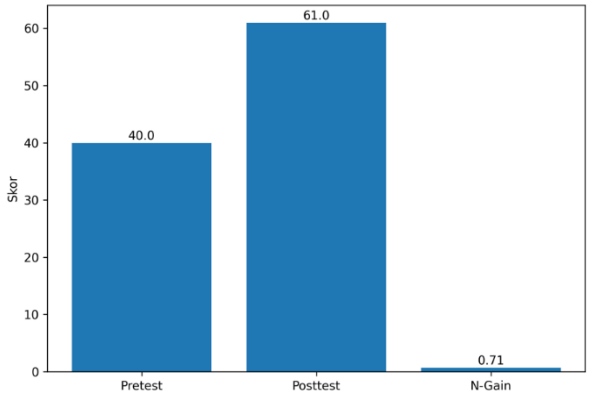

Figure 3. Recapitulation of Average Pretest, Posttest, and N-Gain Scores of Students

Figure 3 shows a summary of the increase in students' conceptual mastery based on pretest and posttest scores. The analysis results show that the average pretest score of 52 increased to 86 in the posttest. The N-Gain value obtained was 0.71, which is categorized as high. These results indicate that the use of e-handouts with the sorogan learning method is effective in improving students' conceptual mastery of acids and bases.

The results of the study indicate that the e-handout on acid-base material using the Sorogan learning method has a very good level of validity based on content and construct aspects. The high percentage of validity indicates that the material, presentation, language, and media display are in accordance with the learning needs of students in the Independent Curriculum. The preparation of e-handouts containing concept maps, learning objectives, materials, learning videos, and practice questions based on numeracy literacy can support a more systematic and directed learning process. This finding is in line with research by [7] which states that e-handouts have a very good level of validity and readability, making them suitable for use as teaching materials in high schools. In

addition, [9] also explained that the development of Flip HTML5-based e-handouts can produce appropriate and attractive learning media for use in the learning process.

The validity of the e-handouts obtained in this study is inseparable from the development of media tailored to student characteristics and 21st-century learning needs. The use of interactive digital displays makes it easier for students to understand abstract concepts in acid-base material, especially in the discussion of acid-base theory and pH calculations. The integration of images, videos, and practice questions in the e-handouts provides a more varied learning experience so that students do not only rely on teacher explanations in class. These results support [10] research which shows that mind mapping-based e-handouts can help students understand the material in a more structured and interesting way. [11] also stated that the use of e-handouts on the excretory system material can increase student learning interest because the media can be accessed flexibly through digital devices.

The practical aspects of this study indicate that students responded positively to the use of e-handouts during learning. Students found it easier to study the material independently because e-handouts could be accessed anytime via electronic devices. Furthermore, the sorogan learning method applied provided students with the opportunity to study the material first before discussing and receiving guidance from the teacher. This condition made students more active and engaged during the learning process. The results of this study align with the research of [8] which stated that application-based e-handouts can increase student engagement students in the learning process. Research by [6] also showed that the use of handouts using the sorogan method met the criteria of being very practical because it helped students learn more independently and in a focused manner.

The application of the sorogan learning method in this study resulted in a more individualized and in-depth learning process. Through this method, students are given the opportunity to understand the material independently and then review it under the guidance of an educator. This learning process helps educators determine each student's level of understanding, thus making learning more effective. The sorogan method also encourages students to be more responsible for their learning process because they must prepare themselves before the lesson begins. This finding supports the research of [6], which explains that the sorogan method can improve students' conceptual mastery of acids and bases through individual learning and gradual repetition of the material.

The study also showed that the use of e-handouts with the sorogan learning method was effective in improving students' conceptual mastery. This was evident in the increase in the average posttest score compared to the pretest, as well as the high N-Gain score. This improvement in learning outcomes occurred because students had the opportunity to study the material independently before the lesson began, thus improving their initial understanding of the concepts. The use of engaging digital media also helped students understand material previously considered abstract and difficult to understand. These results align with research by [3] which stated that the use of chemistry e-modules can significantly improve student learning outcomes. Furthermore, research by [7] also showed that digital teaching materials with good readability can help students understand the material more optimally.

The development of e-handouts in this study is also relevant to the implementation of the Independent Curriculum, which emphasizes student-centered learning and strengthening 21st-century competencies. The Independent Curriculum encourages educators to deliver creative and innovative learning and utilize technology as a learning tool. The developed e-handouts support independent learning, improve students' digital literacy, and provide flexibility in accessing learning materials. These findings support the research of [12], which states that the implementation of the Independent Curriculum requires learning innovations that can increase student engagement and creativity. Furthermore, [13] explain that 21st-century learning requires the

use of technology-based learning media to support optimal student competency development.

Although this study showed positive results, it still has several limitations. The study was only conducted in a limited trial with a relatively small number of students, so the results cannot be generalized widely. Furthermore, the study focused only on acid-base material, so the effectiveness of e-handouts on other chemistry topics is not yet fully understood. Another limitation lies in the use of the sorogan learning method, which requires more time because the learning process is carried out individually. Therefore, further research is expected to conduct trials on a larger scale, develop e-handouts for other chemistry topics, and combine more varied learning methods to make learning more effective and efficient.

CONCLUSION

The development of e-handouts on acid-base material using the sorogan learning method showed highly valid, practical, and effective results for use in chemistry learning in high school. The use of e-handouts was able to improve students' mastery of concepts, as demonstrated by improved posttest results and high N-Gain scores. This study implies that the use of digital teaching materials based on the sorogan method can be an alternative learning method that supports the implementation of the Independent Curriculum because it can create more independent, interactive, and student-centered learning. However, this study still has limitations because it was only conducted on a limited trial scale and focused on acid-base material, so the results cannot be generalized widely. Therefore, further research is recommended to develop e-handouts on other chemistry materials with a larger number of research subjects and combine more varied learning methods to determine the effectiveness of the learning media in more depth.

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