ARFAK CHEM
Chemistry Education journal
Vol 9 No 1, pp.841-849, 2026
p-ISSN: 2615-627X, e-ISSN: 2615-6255
Available online at: https://journalfkipunipa.org/index.php/accej

The effectiveness of a website-based interactive medium (chem go) on electrolyte and non-electrolyte solutions to improve chemistry learning outcomes

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ARTICLE INFO:

Revised: 2026-05-11
Accepted: 2026-06-17
Published: 2026-06-18

Keywords:

Chem Go, electrolyte solutions, learning outcomes, pre-experiment

ABSTRACT

Learning media that lacks interactivity often causes students to become bored quickly and contributes to low learning outcomes. To meet that challenge, interactive website-based media such as Chem Go has been developed to offer a more effective learning experience. This innovation is designed to improve student learning outcomes. The purpose of this study is to examine the effectiveness of the website-based interactive media (Chem Go) in teaching electrolyte and non-electrolyte solutions. This study is a Research and Development (R&D) study using the 4D model. The population of this study is all Grade XI students at State Senior High School 6 Samarinda in the 2025/2026 academic year. The samples in this study were from classes XI-C and XI-D. The data collection technique used was cluster random sampling. The method used in this study was a pre-experiment with a two-group pre-test post-test design without a control group. The N-Gain analysis results showed values of 0.45 for class XI-C and 0.41 for class XI-D, both in the moderate category. In contrast, the Effect Size was 1.09 for class XI-C (high) and 1.41 for class XI-D (very high). The students' response to this media was positive, falling into the positive category for understanding, attitude, and active participation. These results confirm that Chem Go is an effective medium for learning chemistry and improves learning outcomes

How to cite: Fanjalu, A. G. N. R. G. F., Irawan, M. H., Lestari, S., Kusumaningtyas, P., Rahmadani, A., & Rosaliyanti. (2026). The effectiveness of a website-based interactive medium (chem go) on electrolyte and non-electrolyte solutions to improve chemistry learning outcomes. *Arfak Chem: Chemistry Education Journal, 9*(1), 841-849. https://doi.org/10.30862/accej.v9i1.1278

1. INTRODUCTION

Education is a vital aspect that every individual must undertake to improve their quality of life. Through education, a person can improve their behaviour and knowledge. The educational process involves teachers imparting knowledge and skills to pupils to develop their potential, so they can become more creative and generate innovative ideas. At the senior secondary level, students study various fields of knowledge, including chemistry. The chemistry curriculum at senior secondary school covers everything that involves skills and reasoning (Rosmiati, 2022).

Low student achievement is attributed to low motivation and interest in learning, which leads to students being reluctant to attend lessons and not engaging actively in learning, thereby having a direct impact on low academic performance (Sirait et al., 2025). Furthermore, the use of learning resources is ineffective, and the learning process remains teacher-centred (Lela et al., 2023). The low level of student motivation in chemistry is due to the subject containing many abstract concepts that are difficult to grasp. To aid understanding, three levels of representation are required: macroscopic, submicroscopic, and symbolic. Interactive media are crucial as they can present all three representations simultaneously. One such medium is the Chem Go website, which offers features to display these three levels of representation more clearly (Sahidi et al., 2025).

One way to improve learning outcomes is through the use of learning media. These serve as learning resources that help teachers broaden pupils' knowledge. With the variety of learning media used by teachers, pupils can absorb knowledge more effectively. The use of learning media can stimulate pupils' interest in exploring new aspects of the material presented by the teacher, thereby making the material easier to understand. Engaging learning media can stimulate students during the learning process (Nurrita, 2018). Interactive learning media can be an effective choice to support the learning process, particularly in situations involving distance learning. This media enables efficient and effective learning to support learning success. (Sitorus et al., 2025).

The research question for this study is: Is the web-based interactive medium (Chem Go) effective in improving students' learning outcomes on the topic of electrolyte and non-electrolyte solutions? The aim of this study is to determine the effectiveness of the web-based interactive medium (Chem Go) in improving students' learning outcomes on the topic of electrolyte and non-electrolyte solutions.

2. METHODS

A. Type of Research

This study is a research and development (R&D) project based on the 4D model: Define, Design, Development and Disseminate. Irawan (2024) has already conducted research from the Define stage through to the Development stage, specifically in the validation phase, whilst Septiani's study (2026) reached the development stage at the practicality testing phase. Consequently, this study continues the development stage with a focus on testing effectiveness.

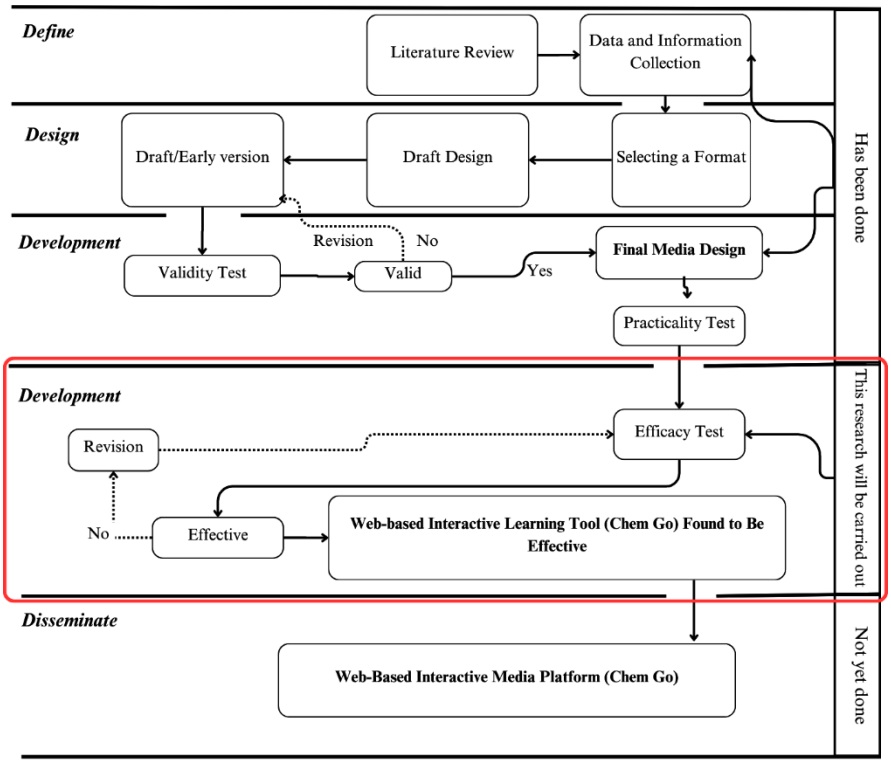

Figure 1. Research Design of the 4D Model

B. Research Instruments

This study utilised various instruments, such as pre-test and post-test questions and observation sheets for learning activities. The pre-test and post-test questions, together with the student feedback questionnaire, helped to evaluate how effectively the web-based interactive medium (Chem Go) functioned during the learning process. Observation sheets for teachers and students were used to assess the user-friendliness of the web-based interactive medium (Chem Go).

C. Data Analysis Techniques

The pre-test and post-test data were analysed using normality and homogeneity tests, as well as a t-test, in SPSS at a significance level of 0.05. The data were deemed normal and homogeneous if the significance value was ≥ 0.05, and a significant difference was present if the Sig. (two-tailed) ≤ 0.05. The effectiveness of the medium was then measured using N-Gain, categorised as high (>0.70), moderate (0.30–0.70), and low (≤0.30). If the result was at least in the moderate category, this was followed by an effect size test using the formula that compares the post-test and pre-test means to the pre-test standard deviation to determine the magnitude of the effect. Furthermore, student response data were analysed descriptively in the form of percentages, categorised as very positive (85–100%), positive (70–85%), less positive (50–70%), and not positive (≤50%) (Simbolon et al., 2025).

3. RESULTS AND DISCUSSIONS

A. Result

The students' learning outcomes in this study were assessed using pre- and post-tests, which aimed to assess their initial abilities and the improvement in their learning following the learning process. The data on these learning outcomes were subsequently presented and analysed to identify differences in student achievement before and after the learning intervention. The learning outcomes of Year 11 students at State Senior Secondary School No. 6 Samarinda were derived from the pre-test and post-test results presented in Figure 2.

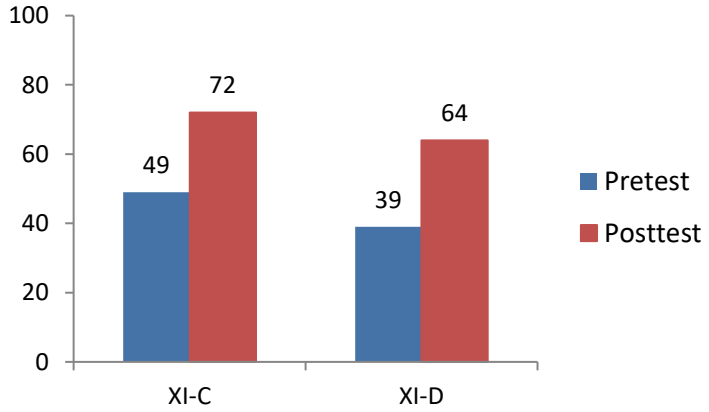

Figure 2. Average Pre-test and Post-test Scores

Once the pre-test and post-test results have been obtained, the next step is to conduct a normality test to determine whether the mean values of the pre-test and post-test data are normally distributed or not. This test is carried out using the Shapiro-Wilk test via the SPSS application.

The pre-test and post-test data for Class XI C were found to be normally distributed; it can therefore be concluded that the data are normally distributed as the significance value is < 0.05, so the analysis proceeded to a homogeneity test. The pre-test and post-test data for Class XI D were not normally distributed as the significance value was > 0.05; therefore, a non-parametric test was conducted to determine whether there was a difference between the pre-test and post-test results.

The results of the analysis show that the significance value of the homogeneity test for Class XI-C regarding the variance of the pre-test and post-test data is 0.995. This value is greater than the significance level of 0.05; therefore, it can be concluded that the variances of the two datasets are homogeneous. To test for a significant difference between the pre-test and post-test results in Class XI-C, an analysis was conducted using a paired-sample t-test. Based on the data, a significance value (Sig. 2-tailed) of 0.000 was obtained. As this value is smaller than the significance level of 0.05, it can be concluded that there is a significant difference between the pre-test and post-test results. Based on these findings, the analysis was then continued with an N-Gain test. The results of the non-parametric test for Class XI-D show that the Asymp. Sig. (2-tailed) value is 0.000. This value is smaller than the significance level of 0.05, so it can be concluded that there is a significant difference between the students' learning outcomes before (pre-test) and after (post-test). Furthermore, the analysis continued with an N-Gain test to determine the level of improvement in learning outcomes.

Table 1. Results of N-Gain Analysis

Class	Average pre-test score	Average post-test score	N-Gain	Category
XI-C	49	72	0.45	Moderate
XI-D	39	64	0.41	Moderate

Based on the results of the N-Gain analysis in Table 1, the calculated N-Gain value for Class XI-C was 0.45, which falls into the moderate category. The N-Gain value for Class XI-D was 0.41, which falls within the moderate category. Consequently, the analysis proceeded to the effect size test. These findings indicate that the improvement in students' learning outcomes following the intervention falls within the moderate category.

Table 2. Results of Effect Size Analysis

Class	Average pre-test score	Average post-test score	Std.Dev	∑posttest-∑pretest	Effect Size	Category
XI-C	49	72	21.05	23.00	1.09	High
XI-D	39	64	17.68	25.00	1.41	Very High

Table 2 shows that the effect size for Class XI-C was 1.09, falling into the high effect category, whilst that for Class XI-D was 1.41, falling into the very high effect category. Data supporting the implementation of the web-based interactive media (Chem Go) was obtained from observations of teacher and student activities, as shown in Figure 3.

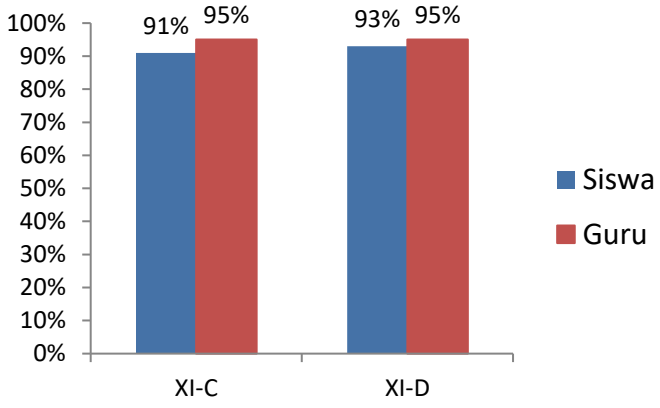

Figure 3. Observation of Teacher and Students Activities

Figure 3 shows that the average percentage of teacher and student activity in lessons using the web-based interactive media (Chem Go) in Class XI-C reached 91% for students and 95% for teachers, which is classified as 'very good'. Meanwhile, the average percentage of teacher and student activity in learning using the same medium in Class XI-D was 93% for students and 95% for teachers, and was also classified as 'very good'.

The data supporting the effectiveness of this learning medium were obtained from the results

of a questionnaire assessing students' responses to learning using a web-based interactive medium (Chem Go) in an effort to improve learning outcomes on the topic of electrolyte and non-electrolyte solutions. The responses of students in classes XI-C and XI-D are presented in Figure 4.

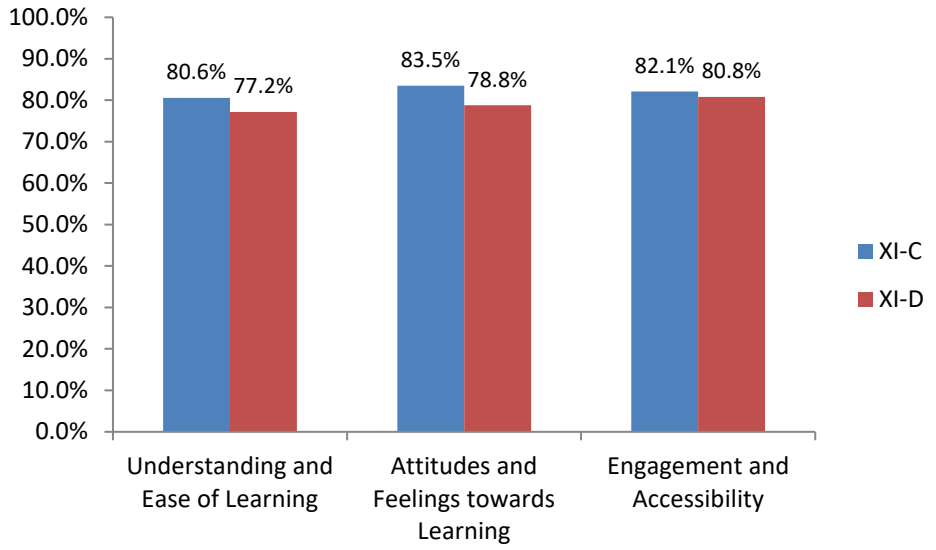

Figure 4. Student Feedback Questionnaire

Based on the results of a questionnaire regarding students responses to the use of the web-based interactive media (Chem Go), it was found that all the indicators measured fell into the positive category. The average percentage scores achieved were 78.9% for the aspects of understanding and ease of learning, 81.2% for the aspects of attitude and feelings towards learning, and 81.5% for the aspects of engagement and ease of access, derived from the mean values across two classes.

B. Discussions

Based on the results of the analysis of the average N-Gain scores, values of 0.45 for Class XI-C and 0.41 for Class XI-D were obtained, both of which fall into the moderate category. The results of the study indicate that the website-based interactive media (Chem Go) has been proven to improve student learning outcomes. This study indicates that the web-based interactive media (Chem Go) has been proven effective in improving student learning outcomes, particularly regarding the topics of electrolyte and non-electrolyte solutions. Consequently, the use of this media can serve as a suitable alternative to support a more interactive and meaningful chemistry learning process. In line with the research by Wahab et al. (2021) which states that the use of interactive learning media can improve student learning outcomes, with N-Gain scores falling within the moderate category, meaning that the learning process can be considered effective. Furthermore, an effect size test was conducted to determine the magnitude of the effect or influence of the web-based interactive media (Chem Go) on learning outcomes. Based on the analysis results, the average effect size value was 1.09 for Class XI-C, which falls into the high

category, and 1.41 for Class XI-D, which falls into the very high category. These results indicate that the web-based interactive medium (Chem Go) has a significant positive impact on improving students' learning outcomes; it can therefore be concluded that the use of this medium is effective in supporting an interactive and meaningful chemistry learning process. The difference in effect size values between Class XI-C and Class XI-D is due to differences in learning ability, resulting in differing outcomes. The difference in effect size values between Class XI-C and Class XI-D may be influenced by differences in the timing of the lessons. Lessons in Class XI-C were held close to break time, so students' psychological state and concentration levels tended to decline as they were more focused on wanting to take a break. The effectiveness of the web-based interactive learning medium (Chem Go) in this study was supported by the results of teacher and student observations, with a 95% rating in the 'very good' category for teachers and a 92% rating in the 'very good' category for students, which represent the average scores from two classes.

The effectiveness of the web-based interactive media (Chem Go) is further supported by the results of the student feedback questionnaire. As shown in Figure 4, the indicators for understanding and ease of learning recorded percentages of 80.6% in Class XI-C and 77.2% in Class XI-D, calculated separately for each class. both falling within the positive category. These findings indicate that the Chem Go interactive media is capable of helping students understand the material on electrolyte and non-electrolyte solutions more easily. These results are in line with the research by Hermaliani et al. (2023), which states that interactive learning media makes a tangible contribution to improving the ease of understanding the material and the smoothness of the students' learning process. The indicators of attitude and feelings towards learning also received a positive rating, with a percentage of 83.5% in Class XI-C and 78.8% in Class XI-D, calculated separately for each class. This indicates that the use of interactive media is capable of fostering positive attitudes and feelings among students during the learning process, which leads to increased interest, motivation and active participation. These findings are supported by Zainuddin (2024) and Husaeni et al. (2022), who confirm that interactive media can create engaging learning experiences, boost motivation and help students understand abstract chemical concepts. Furthermore, the indicators of activity and ease of access achieved a percentage of 82.1% in Class XI-C and 80.8% in Class XI-D, with the results computed separately for each class. falling into the positive category. These results indicate that Chem Go is not only easily accessible but also effective in encouraging student engagement during learning. These findings align with the research by Hartono et al. (2025) and Ulfaa et al. (2025), who concluded that the ease of access to digital media and the use of interactive multimedia can enhance the effectiveness of learning through more dynamic and in-depth interactions.

The research findings indicate that the web-based interactive medium (Chem Go) on the subject of electrolyte and non-electrolyte solutions has proven effective as an alternative medium for chemistry teaching. This effectiveness is evident from the N-Gain scores of Class XI-C, which stood at 0.45 (moderate category), and Class XI-D, which stood at 0.41 (also in the moderate category). The effectiveness of this medium is further reinforced by the Effect Size scores of Class XI-C, which stood at 1.09 (high category), and Class XI-D, which stood at 1.41 (very high category).

The effectiveness of this medium is further supported by the results of the student response questionnaire, where the average response rate reached 82% in Class XI-C and 79% in Class XI-D, both falling within the 'positive' category.

4. CONCLUSIONS

Based on the results of a study conducted at SMAN 6 Samarinda, the web-based interactive medium (Chem Go) proved effective in improving students' learning outcomes on the subject of electrolyte and non-electrolyte solutions. This is evidenced by an average N-Gain score of 0.45 in Class XI-C and 0.41 in Class XI-D, which fall into the moderate category, as well as an Effect Size of 1.09 in Class XI-C (high category) and 1.41 in Class XI-D (very high category). Positive student responses to the attitude and feelings indicators regarding learning were 83.5% in Class XI-C and 78.8% in Class XI-D. Meanwhile, the indicators for engagement and ease of access achieved percentages of 82.1% and 80.8% in Class XI-C and Class XI-D, respectively. As for the indicators of understanding and ease of learning, these reached 80.6% in Class XI-C and 77.2% in Class XI-D. Thus, the web-based interactive medium (Chem Go) can serve as an effective and engaging alternative for chemistry learning, capable of significantly improving students' learning outcomes.

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