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The Effectiveness of PowerPoint-Assisted Redox Learning: A Quasi-Experimental Study with Independent Pretest–Posttest Samples in Grade XII Students

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Abstract: The Effectiveness of PowerPoint-Assisted Redox Learning: A Quasi-Experimental Study with Independent Pretest–Posttest Samples in Grade XII Students. Objectives: This study examined the effectiveness of PowerPoint (PPT)-assisted instruction on Grade XII students' learning outcomes in redox reactions by comparing achievements between pretest and posttest respondent groups**.** A quantitative quasi-experimental approach with an independent pretest–posttest design was employed. Participants were Grade XII students (population 36) with 33 respondents completing the pretest and 24 respondents completing the posttest. The instrument was a Google Form-based redox concept test (0–100). Data were analyzed using the Mann–Whitney U test, and effect size was calculated using $r = Z / \sqrt{N}$. The findings showed that the posttest group achieved better learning outcomes than the pretest group. The difference was statistically significant and indicated a moderate-to-large effect. These results suggest that PPT-assisted redox learning contributes positively to students' understanding, although the findings should be interpreted cautiously because the respondents in the pretest and posttest were not identical.

Keywords: PowerPoint, redox reactions, learning outcome, quasi-experiment, Mann–Whitney U

Abstrak: *Efektivitas Pembelajaran Redoks Berbantuan PowerPoint: Studi Kuasi-Eksperimen dengan Sampel Pretest–Posttest Independen pada Siswa Kelas XII. Penelitian ini menganalisis efektivitas pembelajaran berbantuan PowerPoint (PPT) pada materi redoks dengan membandingkan capaian hasil belajar antara kelompok responden pretest dan posttest siswa kelas XII. Penelitian menggunakan pendekatan kuantitatif dengan desain kuasi-eksperimen pretest–posttest sampel independen. Populasi berjumlah 36 siswa; responden pretest sebanyak 33 dan responden posttest sebanyak 24. Instrumen berupa tes konsep redoks berbasis Google Form dengan rentang skor 0–100. Data dianalisis menggunakan uji Mann–Whitney U dan ukuran efek dihitung dengan rumus $r = Z / \sqrt{N}$. Hasil penelitian menunjukkan bahwa kelompok posttest memiliki hasil belajar yang lebih baik dibandingkan kelompok pretest. Perbedaan tersebut signifikan secara statistik dan menunjukkan pengaruh pada kategori sedang hingga besar. Temuan ini menunjukkan bahwa pembelajaran redoks berbantuan PPT berkontribusi positif terhadap pemahaman siswa, meskipun hasil perlu diinterpretasikan secara hati-hati karena responden pretest dan posttest tidak identik.*

Kata kunci: *PowerPoint, reaksi redoks, hasil belajar, kuasi-eksperimen, Mann–Whitney U*

▪ INTRODUCTION

The development of science and technology that has entered the era of the Industrial Revolution 4.0 requires various aspects of life to be carried out with the support of digital technology. This condition also encourages the world of education to adjust and develop the learning process in line with these progresses. Therefore, the use of digital technology-based learning media is important so that students can achieve competencies that are in accordance with the demands of learning in the digital era. In line with the rapid development of technology today, the learning process also continues to develop and requires educators to present various new innovations in its implementation. This is in line with the demands of 21st century education, where teachers are expected to be able to master and apply technology in learning so that the teaching and learning process takes place more effectively and efficiently. The application can be done through the use of technology-based learning media. Learning media is an important part of educational technology that teachers can use to support the achievement of learning goals optimally. (Chastanti, 2024; Dewi, 2024; Dito & Pujiastuti, 2021)

In addition to the general integration of technology in education, it is also important to examine how technology-based media are implemented in actual classroom settings. Based on interviews conducted by researchers with teachers at SMA X, the learning media used were power points, LKS books and there were also those who used package books but were very limited in availability. In practice, teachers often use PPT (power point) because it is considered quite effective. Power Point is a learning medium that allows the presentation of various elements such as images, text, graphics, movies, videos, sounds, and other objects in one or several pages called "slides". In line with that, Widhayanti (2021) explained that PowerPoint functions as a presentation tool to convey material that has been summarized and packaged in the form of slides, so that the audience can more easily understand the teacher's explanation through visualizations that are presented concisely and clearly (Illahi et al., 2021; Widhayanti & Abduh, 2021).

Among various chemistry topics, redox reactions are considered one of the most difficult concepts for students to understand. The use of power points as a teaching medium was carried out by researchers in the material of the redox concept. Redox stands for oxidation reduction, which is a chemical reaction in which electron transfer occurs between two substances. This material is very important because its implementation is related to daily life, ranging from metabolism in the human body, metal corrosion, industrial processes, to the generation of electrical energy through electrochemical cells. However, according to Hanisyah in 2021, there are still many misconceptions that occur. Students were detected to have misconceptions in several sub-materials, namely the determination of the oxidation number by 46%, the change in the oxidation number by 23%, the concept of reducers and oxidizers by 54.09%, and autoredox reactions by 69.98%. The misconception is allegedly influenced by students' low ability, motivation, and interest in learning, as well as the use of learning methods and learning resources that are still limited (Hasniyah & Muchtar, 2021; Phitantyos & Aini, 2025).

Previous studies have reported the effectiveness of PowerPoint-assisted learning in various chemistry topics, including redox at lower grade levels and salt hydrolysis (Nadilla Mutia Erliansyah & Syamsi Aini, 2023; Nurfalah & Aini, 2023). However, its application in more complex redox material at the Grade XII level remains limited. At this level, students are required to understand more abstract and complex concepts, which often lead to misconceptions. Therefore, this study focuses on examining the effectiveness of PowerPoint-assisted learning in Grade XII redox material. Therefore, an

appropriate learning medium is needed to help students understand abstract redox concepts more effectively. Previous research has stated that the effectiveness of using power point media can increase students in understanding the material. According to research conducted by Siti, 2025 can improve vocabulary comprehension and pronunciation from an average pre-test score of 71.13 to 85.15 in the post test. Another study stated that the results of the analysis showed that PowerPoint interactive media had a positive and significant effect on student understanding (t count 3.040 > t table 2.036; p=0.000<0.05) with a contribution of 21.9% (R^2=0.219). Effective results in the use of power points are also shown from Wahyuni's 2025 research that the average result of the pretest score is 57.7 and the post test is 76.0. (Monika Flora Manik et al., 2025; Wahyuni et al., 2025).

Although previous studies have reported positive findings, there are still several limitations in the existing literature. Based on previous research, positive results were obtained in the use of power points as a learning medium. However, studies specifically examining the effectiveness of PowerPoint-assisted learning in redox material at the Grade XII level are still limited. Therefore, the author conducted this study to describe the achievement of redox learning outcomes of grade XII students before and after PPT-assisted learning and to test the difference in achievement between the pretest (n=33) and posttest (n=24) respondent groups using statistical tests for independent samples. The research findings are expected to make a practical contribution for teachers in refining teaching tools and more structured redox learning strategies.

▪ METHOD

Based on the research gap identified in the previous section, this study employed a quantitative approach to examine the effectiveness of PPT-assisted learning. This study used a quasi-experimental design, which is considered a relevant and adaptable methodological approach in educational research(Lilis Saputri & Mardiati, 2025). This research is a quantitative research with a quasi-experimental design. The design used is a pretest–posttest with a group of independent samples (non-equivalent independent samples), because the respondents who fill out the pretest and posttest are not completely the same**.** Operationally, research is carried out by giving an initial test (pretest), carrying out redox learning assisted by PowerPoint media (PPT), then giving a final test (posttest). The research design can be represented as O_1– X – O_2, where O_1 is the pretest, X is PPT-assisted learning, and O_2 is the posttest. The main limitation of this design is the absence of individual pairs between pretest and posttest, so causal inference is limited to comparing the achievements of two groups of respondents before–after treatment.The location of this research is at SMA X in the city of Semarang. The research was conducted during internship activities in September 2025. The material tested and taught is redox reactions**,** including the definition of redox, the concept of oxidation-reduction, determination of oxidizers/reducers, and oxidation numbers in compounds/ions.The research population is all students of grade XII totaling 36 students. The sampling technique used was saturated sampling, in which all members of the population were involved in the study. The participation of the instrument filling at each stage, namely:

- Pre-test (O_1): 33 answer
- Posttest (O_2): 24 responses

The difference in the number of pretest and posttest respondents occurred due to variations in the participation in filling in instruments at the time of implementation.

Therefore, the data were analyzed as two independent samples**.** The variables in this study are;

1. Independent variable (X**):** PowerPoint media-assisted redox learning (PPT).
2. Bound variable (Y): Redox learning outcomes, which are measured through redox test scores (0–100) on the pretest and posttest.

This design was selected because the respondents who participated in the pretest and posttest were not completely identical, so the data could not be analyzed using paired samples and were treated as independent samples. The treatment consisted of one meeting of PPT-assisted redox learning covering oxidation, reduction, oxidizing agents, reducing agents, and oxidation numbers. The material was presented using structured slides followed by examples and practice questions.

The research instrument used was a Google Form-based redox concept test with automatic scoring in the range of 0–100. The instrument was validated through expert judgment by a chemistry teacher who teaches Grade XI and XII students and has approximately 30 years of teaching experience to ensure its alignment with the learning objectives, and it was revised based on the expert's suggestions. The test is designed to measure indicators of understanding the concept of redox which includes the ability to define redox reactions, understand the concept of oxidation, identify substances that undergo reduction (related to the concept of oxidizer/reducer), and determine oxidation numbers and oxidation numbers. The instrument is designed according to the indicators of redox material learning achievement in grade XII and is used in the pretest and posttest stages. To maintain research ethics, the identity of respondents on the data from filling in the instrument is anonymized and only used in aggregate form in the research report. This instrument is adjusted to the learning objectives.

Data were analyzed using SPSS through descriptive and inferential statistics. Descriptive analysis was conducted to describe students' learning outcomes in the pretest and posttest groups, including the number of samples, minimum and maximum scores, median, and mean.Inferential analysis was performed using the Mann–Whitney U test to examine differences between two independent groups at a significance level of $\alpha = 0.05$. This test was selected because the pretest and posttest data were obtained from different respondents. The hypotheses were formulated as follows: H0: there is no difference in redox learning outcomes between the pretest and posttest groups; H1: there is a difference in redox learning outcomes between the pretest and posttest groups. The decision criterion was that H0 is rejected if $p < 0.05$ and accepted if $p \geq 0.05$. To strengthen the interpretation, effect size was calculated using the formula $r = Z / \sqrt{N}$, where Z is the test statistic obtained from SPSS output and N is the total number of respondents (Pallant, 2020). The effect size was interpreted as small ($r = 0.1$), medium ($r = 0.3$), and large ($r = 0.5$).

▪ RESULT AND DISCUSSION

1) Description of Pretest and Posttest Score Comparison (Based on Ranks)

Based on the Ranks output on the Mann–Whitney test from SPSS, the pretest group ($n = 33$) had a mean rank of 24.14 with a sum of ranks of 796.50. Meanwhile, the posttest group ($n = 24$) had a mean rank of 35.69 with *a sum of ranks* of 856.50. A higher mean rank of the posttest indicates that the achievement of posttest scores tends to be at a higher rank than the pretest, so the achievement of learning outcomes at the posttest stage is relatively better.

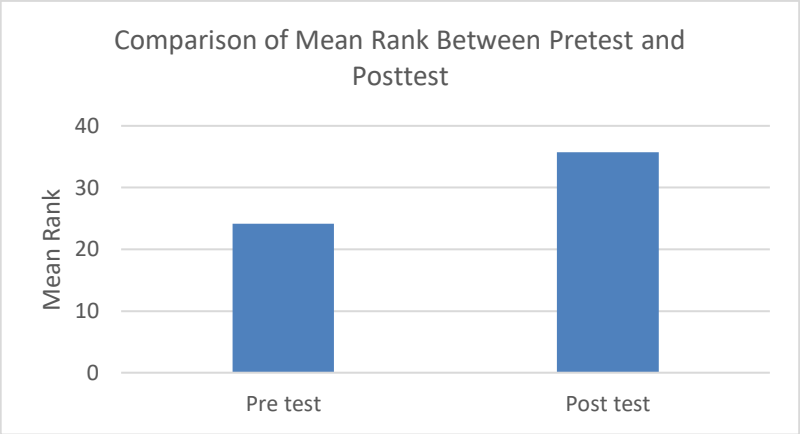

Figure 1. Comparison of Mean Rank Between Pretest and Posttest

Table 1. Rank pretest score posttest

Ranks				
	Prepost	N	Mean Rank	Sum of Ranks
Value	Pretest	33	24.14	796.50
	posttest	24	35.69	856.50
	Total	57		

2) Differential Test Using Mann–Whitney U

The Mann–Whitney U test was conducted to test the hypothesis of differences in pretest and posttest scores in two independent groups. The SPSS output results show Mann–Whitney U = 235.500, Z = −3.152, and Asymp. Sig. (2-tailed) = 0.002. Since the p-value is less than 0.05, H0 is rejected, so there is a significant difference between the pretest and posttest results.

Table 2. Mann-Whitney U test results

Test Statistics[a]	
	Value
Mann-Whitney U	235.500
Wilcoxon W	796.500
Z	-3.152
Asymp. Sig. (2-tailed)	.002
a. Grouping Variable: prepost	

3) Effect Size

To reinforce the interpretation, the effect size was calculated using the formula $r = |Z| / \sqrt{N}$, with N representing the total number of respondents. The calculation produced an effect size of approximately 0.42, which falls into the medium-to-large category. This indicates that the difference between the pretest and posttest groups was not only statistically significant but also practically meaningful in the context of learning .The statistical findings indicate that PPT-assisted learning contributed to better student performance. The posttest group showed higher achievement than the pretest group, suggesting that students performed better after the implementation of PPT-assisted learning. These findings indicate that the use of PPT was associated with improved understanding of redox concepts.

The results of the above study show that there is an increase in student learning outcomes after using power point learning media. This is because power points have advantages over other media. PowerPoint has the advantage of being able to present material in an attractive, visual, and concise manner that makes it easier for students to understand information PowerPoint also has a variety of tools that can be used to help students improve their understanding. In addition, the media is flexible, can be used repeatedly, and is easy to store for reuse (Nurwahidin et al., 2024a; Stavinibelia Stavinibelia et al., 2024).

Power point is quite effective in redox material. Redox reaction materials contain abstract and stratified chemical concepts, such as electron transfer and changes in oxidation numbers that cannot be directly observed. In addition, this material is also related to daily life, for example in the iron rusting process. This finding is in line with previous research that the use of power point media can improve student learning outcomes (Ahmad Muflih Saefuddin, 2024; Azizatis Salma & Syamsi Aini, 2023; Nurwahidin et al., 2024; Rizqi & Hidayatullah, n.d.; Teddy Hardiansyah et al., 2024).

The difference between this study and the previous research is that in the study of the effectiveness of power point in grade 10 redox material, while this study uses grade 12 redox material (Nurfalah & Aini, 2023). Then, the research focuses on salt hydrolysis materials. So the novelty of this research lies in the effectiveness of power points in grade 12 redox materials. (Nadilla Mutia Erliansyah & Syamsi Aini, 2023)

However, this study has limitations because the pretest and posttest respondents are not completely the same and have not used the control group. It is hoped that in the next research it can be used in the control experiment class to be more valid, and the use of ppt can be enriched with its features so that in addition to improving learning outcomes, it can also increase student motivation in learning.

▪ CONCLUSION

This study showed that PPT-assisted learning improved students' understanding of redox concepts. The posttest group achieved better learning outcomes than the pretest group, with a moderate-to-large practical effect. However, because the pretest and posttest respondents were not identical, the findings should be interpreted cautiously. Future studies are recommended to use paired samples or control groups to strengthen the validity of the results.

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