**Effects of Khan Academy Instructional Videos to Students’ Conceptual Understanding in Molecular Polarity**

**Arnel R. Andrin1, Kier L. Ecle2, Daryl James B. Capacio3**

1Don Ruben Edera Ecleo Sr. Memorial National High School, P-3 Don Ruben (Baltazar), San Jose, Province of Dinagat Islands 8427, Philippines

2College of Teacher Education, Surigao del Norte State University (SNSU), Narciso Street, Surigao City 8400, Philippines.

3 New Nazareth National High School, New Nazareth, Basilisa, Province of Dinagat Islands 8413, Philippines

Corresponding author: A. R. Andrin, aandrin@ssct.edu.ph

**ABSTRACT**

 This study examines the effectiveness of Khan Academy instructional videos in enhancing students' understanding of molecular polarity compared to traditional PowerPoint lectures. Utilizing a quasi-experimental design, the research involved 70 Senior High School students divided into control and experimental groups. The control group received conventional lectures, while the experimental group used Khan Academy videos. Pre-test and post-test assessments measured conceptual understanding and retention. The results indicated that the experimental group consistently achieved significantly higher post-test scores compared to the control group. Statistical tests, including paired and independent sample t-tests, validated the effectiveness of video-based learning. These results suggest that using digital learning platforms like Khan Academy can greatly improve student engagement and understanding of concepts, proving to be an effective approach for teaching complex scientific topics such as molecular polarity.

**Keywords:** Khan Academy, molecular polarity, video-based learning.

**INTRODUCTION**

 The integration of technology in education has transformed traditional teaching methods, especially in science education. Khan Academy, a globally recognized open educational resource (OER), offers an extensive collection of instructional videos that are accessible anytime and anywhere, effectively supporting student learning (Yassine et al., 2020). According to Torres et al. (2022), the interactive nature of these videos simplifies complex concepts and aligns with modern teaching approaches that emphasize active student participation. Teaching challenging scientific topics like molecular polarity, which involves understanding abstract ideas and is often among the most difficult competencies for students, highlights the need for enhanced educational strategies to bridge this knowledge gap (Crowther et al., 2023; Talanquer, 2014).

 Recent research suggests that traditional teaching methods may not address diverse student learning styles, potentially leading to gaps in comprehension and engagement (Putri, 2021). Video instruction has been shown to enhance understanding and retention of scientific concepts, emphasizing the importance of evaluating the effectiveness of these resources in chemistry education (Stieff et al., 2018; Brame, 2016). However, while videos can boost engagement and visually clarify complex ideas, they do not always result in significant learning gains (Amalric et al., 2022; Kelly & Rutherford, 2017). This highlights the need to assess the impact of Khan Academy videos within the Senior High School Curriculum, particularly in enhancing students' understanding of molecular polarity, a fundamental concept in chemistry (Sentanin et al., 2023).

 This study explores how digital learning tools like Khan Academy can aid students in mastering molecular polarity, a challenging yet essential topic. Additionally, evaluating the role of video instruction in enhancing student engagement and comprehension can provide valuable insights for educators and curriculum developers, helping to establish effective strategies for integrating technology into science teaching (Blacer-Bacolod & Bacolod, 2020; Scagnoli et al., 2017).

**OBJECTIVE**

 This study aims to assess the impact of Khan Academy instructional videos on enhancing students' understanding of molecular polarity concepts. The results of this research could provide valuable insights for optimizing teaching methods to better support students' learning needs, potentially incorporating blended learning models as a supplementary instructional approach.

**REVIEW OF RELATED LITERATURE**

 The use of video-based learning (VBL) in education has become increasingly popular, especially with platforms like Khan Academy that offer instructional videos on a wide range of subjects, including chemistry. Research by Putri (2021) indicates that VBL can improve student engagement and understanding of complex topics, such as molecular polarity, by providing visual and auditory learning experiences that cater to different learning preferences. Khan Academy's instructional videos are particularly effective because they simplify complex ideas into smaller, manageable sections, enabling students to learn at their own pace and revisit difficult content when needed (Blacer-Bacolod & Bacolod, 2020). This adaptable approach is especially useful in chemistry education, where students often find it challenging to grasp abstract ideas related to molecular interactions and properties (Irwanto et al., 2024).

 Molecular polarity is a fundamental chemistry concept that affects various chemical properties and behaviors, yet misconceptions about it are common and can hinder students' understanding (Li et al., 2022). For example, Ibañez & Pentang (2021) note that misunderstandings about the relationship between molecular shape, electronegativity, and polarity can create gaps in students' knowledge. Instructional videos help clarify these misconceptions by offering clear, visual explanations of molecular polarity and its role in chemical interactions (Bayda & Sutliff, 2020). Studies show that multimedia resources help students build a more cohesive understanding of complex scientific ideas by connecting theoretical knowledge to real-world applications (Bennison et al., 2020).

 Continuing research on the impact of Khan Academy videos on students' understanding of molecular polarity underscores the potential of video-based learning to transform educational practices. By addressing misconceptions, using visual aids, and promoting interactive learning, these videos can significantly enhance students' grasp of challenging chemical concepts. As teaching methods evolve, it is essential to explore and improve the use of digital tools like Khan Academy to better support learners in chemistry education (Yassine et al., 2020).

**METHODOLOGY**

This section covers the entry protocol, research setting, research design, participants, research tools, data collection process, and data analysis methods.

**Entry Protocol**. A research permit (RP) was obtained through a formal communication letter addressed to the principal of the Senior High School (SHS) Department as a sign of respect, professionalism, and ethical compliance before conducting the study.

**Research Environment**. The study was conducted in Don Ruben (Baltazar), San Jose, located in the Province of Dinagat Islands, Philippines. Global Positioning System (GPS) application has been used to document the exact position and altitude of the study station, referred to as school of Don Ruben Edera Ecleo Sr. Memorial National High School (DREESMNHS). Geographically lies at N 100 0’58’’ E 1250 34’31’’.

**Research Design**. A quasi-experimental design with two groups of Senior High School students enrolled in General Chemistry 1 and Physical Science. One of the two will get the traditional lecture using illustration or PowerPoint presentation for molecular polarity and the other one will do Khan Academy videos on the same topic. A pre-test and post-test employed both groups, in order to determine if there is any difference in retention and comprehension of the topic.

**Research Respondents**.The respondent in this study is involved 70 Senior High School students of Don Ruben E. Ecleo Sr. Memorial National High School (DREESMNHS). Thirty-Five (35) students for the experimental group, and thirty-five (35) students in the control group based on sex determination.

**Table 1. Distribution of Students by Sex and Assigned Study Groups**

|  |  |  |  |
| --- | --- | --- | --- |
|  |  | **Male** | **Female** |
| **Groups** | **n** | **f** | **%** | **f** | **%** |
| Control | 35 | 15 | 50.0 | 20 | 50.0 |
| Experimental | 35 | 15 | 50.0 | 20 | 50.0 |
| **Total** | **70** | **30** | **100.0** | **40** | **100.0** |

**Research Instrument.** A questionnaire with 30 questions in Molecular Polarity crafted from the Deped Caraga Sukdanan Standardized test was used. The demographic profile of the learners, learning experiences with Khan videos and conceptual understanding of molecular polarity were gauged by the survey. To ensure the validity and reliability of test instrument was examined by the statistical tool for validity while reliability was a subject specialists and master teachers before it was employed to the students.

**Data Gathering Procedure.** This quasi-experimental study involves two groups of Senior High School students enrolled in General Chemistry 1 and Physical Science to evaluate the effects of different teaching methods on molecular polarity. One group will receive traditional lectures with PowerPoint presentations and illustrations, while the other group will utilize Khan Academy videos covering the same topic. A pre-test was administered to both groups to assess baseline knowledge before the instructional phase via paper and pen test, which will last for a week. After the intervention, a post-test was conducted to measure immediate comprehension, followed by a retention test two weeks later to evaluate long-term knowledge retention. The pre-test and post-test it composed of 30 multiple-choice questions, and their reliability and validity were ensured through pilot testing or examine by statistical tool and being evaluated by subject specialists and master teachers.

**Data Analysis.** Data was analyzed using descriptive statistics for the totality of scores within the groups. paired t-tests to compare scores within each group and independent t-tests to examine differences between the groups using***Jamovi* *statistical* software**. This approach aims to determine whether video-based learning provides comparable or superior outcomes in comprehension and retention compared to traditional lecture methods.

**RESULTS AND DISCUSSION**

 In this section presented the interpretation and the analysis of the respective results. Tables were used to illustrate the findings of the study and the discussion and interpretation of tabular and graphical data were made for easy understanding.

**Table 2. Pretest and Post-test Scores within the Groups**

|  |  |  |  |
| --- | --- | --- | --- |
| No. of Respondents | Control Groups | No. of Respondents | Experimental Groups |
| **Pretest**  | **Post-test**  | **Pre****test**  | **Post-test**  |
| 1 | 5 | 6 | 1 | 12 | 23 |
| 2 | 9 | 11 | 2 | 9 | 12 |
| 3 | 6 | 9 | 3 | 12 | 28 |
| 4 | 8 | 10 | 4 | 7 | 11 |
| 5 | 3 | 3 | 5 | 8 | 13 |
| 6 | 14 | 18 | 6 | 8 | 12 |
| 7 | 5 | 9 | 7 | 14 | 25 |
| 8 | 12 | 19 | 8 | 9 | 16 |
| 9 | 7 | 9 | 9 | 5 | 11 |
| 10 | 5 | 12 | 10 | 5 | 9 |
| 11 | 7 | 7 | 11 | 8 | 12 |
| 12 | 11 | 14 | 12 | 5 | 5 |
| 13 | 10 | 12 | 13 | 10 | 14 |
| 14 | 3 | 19 | 14 | 10 | 14 |
| 15 | 8 | 21 | 15 | 3 | 6 |
| 16 | 12 | 8 | 16 | 10 | 19 |
| 17 | 8 | 13 | 17 | 10 | 10 |
| 18 | 14 | 11 | 18 | 14 | 19 |
| 19 | 9 | 12 | 19 | 12 | 18 |
| 20 | 11 | 13 | 20 | 13 | 17 |
| 21 | 14 | 8 | 21 | 11 | 13 |
| 22 | 12 | 14 | 22 | 13 | 17 |
| 23 | 14 | 11 | 23 | 16 | 25 |
| 24 | 8 | 14 | 24 | 14 | 16 |
| 25 | 13 | 27 | 25 | 12 | 19 |
| 26 | 11 | 22 | 26 | 14 | 20 |
| 27 | 13 | 9 | 27 | 3 | 8 |
| 28 | 8 | 9 | 28 | 4 | 8 |
| 29 | 14 | 6 | 29 | 7 | 10 |
| 30 | 14 | 5 | 30 | 13 | 24 |
| 31 | 3 | 7 | 31 | 7 | 13 |
| 32 | 4 | 9 | 32 | 4 | 11 |
| 33 | 7 | 13 | 33 | 5 | 16 |
| 34 | 13 | 14 | 34 | 9 | 17 |
| 35 | 7 | 11 | 35 | 6 | 14 |

 The table compares pretest and post-test scores of two groups the control using traditional PowerPoint lectures while in experimental group using Khan Academy videos where each groups has 35 respondents. In the control group, pretest scores ranged from 3 to 14, and post-test scores varied from 3 to 27 shows a mixed improvement. It noticed that some respondents improved significantly, while others showed little or no change which indicates a limited effectiveness of traditional lectures. In contrast, the experimental groups pretest scores ranged from 3 to 16 while post-test scores increasing more consistently, from 5 to 28. Most participants showed significant gains, suggesting that Khan Academy videos were more effective in enhancing learning outcomes. Overall, the experimental group achieved greater and more consistent progress, highlighting the effectiveness of online videos compared to traditional lectures.

**Table 3. Pre-test and Post-test Scores of Experimental and Control Group using Paired Sample T-test**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Test |   | Statistic | df | p |
| Pre-test (C) | Pre-test (E) | Student's t | 0.00 | 34.0 |  1.000 |
| Post-test (C) | Post-test (E) | Student's t | -2.38 | 34.0 | 0.023 |
| Note. Hₐ μ Measure 1 - Measure 2 ≠ 0, p < 0.05 |
|  |

 Table 3, shows the results of the Paired Samples T-Test indicates the significant differences in student scores on the topic of molecular polarity between the control and experimental groups. For the pre-test scores, the t-value is 0.00 with 34 degrees of freedom (df) and a p-value of 1.000. This indicates no significant difference between the pretest scores of the control and experimental groups, suggesting that both groups started with similar levels of knowledge or ability. Whereas, for the post-test scores the t-value is -2.38 with the same degrees of freedom, and the p-value is 0.023. Since the p-value is less than 0.05, this result is statistically significant indicates a meaningful difference in post-test scores between the two groups. Specifically, the negative t-value suggests that the experimental group the used of Khan Academy online videos were outperformed the control group that used traditional lectures with PowerPoint presentations.

**Table 4. Test Difference Scores of Experimental and Control Group using Independent Sample T-test**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Groups |   | Statistic | df | p |
| Control | Student's t | -2.49 | 68.0 | 0.015 |
| Experimental | Student's t | -5.14ᵃ | 68.0 | < .001 |
| Note. Hₐ μ 1 ≠ μ 2, p < 0.05 |
| ᵃ Levene's test is significant (p < .05), suggesting a violation of the assumption of equal variances |
|  |

Table 4, shows the results of the Independent Samples T-Test compares the performance between two groups. For the control group, the t-value is -2.49 with 68 degrees of freedom (df) and a p-value of 0.015. Since the p-value is less than 0.05, the result is statistically significant, indicating a meaningful difference between pretest and post-test scores in the control group, likely due to the traditional lecture method using PowerPoint presentations. Whereas, for the experimental group, the t-value is -5.14 with the same degrees of freedom, and the p-value is less than 0.001, showing a highly significant difference between pretest and post-test scores. This suggests that the use of Khan Academy online videos had a strong positive impact on learning outcomes. Additionally, the note mentions that Levene's test is significant (p < .05), indicating a violation of the assumption of equal variances. This suggests that the variability in scores between the two groups was not consistent, which should be considered when interpreting the results. It means that the findings indicate that both instructional methods led to improvements, but the Khan Academy videos were significantly more effective than the traditional lecture approach.

**CONCLUSION**

 This study demonstrated that instructional methods play a crucial role in influencing student learning outcomes. The control group, which received traditional PowerPoint lectures, showed mixed results in post-test performance, suggesting limited effectiveness. In contrast, the experimental group, which engaged with Khan Academy videos, consistently achieved significant improvements in post-test scores, emphasizing the greater impact of video-based learning. Statistical analyses, including paired and independent sample t-tests, revealed notable differences between the two groups, with the experimental group performing better than the control group. These results indicate that incorporating Khan Academy videos into teaching strategies can enhance student learning outcomes more effectively than conventional lecture approaches.

**RECOMMENDATIONS**

 Based on the results, it is recommended that educators incorporate Khan Academy videos into their teaching methods to improve student learning outcomes. The substantial and consistent gains seen in the experimental group suggest that video-based learning is more effective than traditional PowerPoint lectures. Schools and educational institutions are encouraged to invest in digital resources and provide training to maximize the use of these tools. Future studies should also examine the long-term effects of using online educational videos and assess their effectiveness in various subjects and among different student groups.

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**CONFLICT OF INTEREST**

 The authors declare no conflict of interest.

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