

## Effectiveness of Infographic Video Modules in Enhancing Chemistry Process Skills among 9th Grade Students

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### Abstract

This study analyzed the effectiveness of Infographic video modules in improving ninth-grade students' understanding of the chemistry process skills. This quasi-experimental study examined how well infographic video modules helped ninth-grade students improve their process skills in chemistry. Using purposive sampling, 60 students were randomly assigned to experimental ( $n = 30$ ) and control ( $n = 30$ ) groups. The instrument was content validated by subject experts and demonstrated good internal consistency (Cronbach's  $\alpha = 0.82$ ). The intervention was implemented over 20 instructional days (four weeks). While the control group got traditional training, the experimental group's students were taught using systematically designed infographic video modules. Independent samples  $t$ -test revealed no statistically significant difference between the control and experimental groups at the pre-test level ( $t(58) = 1.48, p > .05$ ), confirming baseline equivalence. The experimental group showed a statistically significant advantage on the post-test ( $t(58) = 4.55, p < .001$ ). When pre-test scores were used as covariates in an ANCOVA to account for initial differences, the adjusted post-test means remained significantly different ( $F(1,57) = 20.84, p < .001$ ). Cohen's  $d$  effect size analysis revealed a very large practical effect for the experimental group ( $d = 3.73$ ), indicating strong instructional impact. The results indicate that graphical video courses considerably enhance secondary-level chemistry process skills.

**Keywords:** infographic video modules, chemistry process skills, ninth-grade students, multimedia learning, student-centered instruction, science education

### Introduction

Education is the process of acquiring knowledge, skills, values, and attitudes through teaching, training, and research, encompassing formal, informal, and lifelong learning. According to UNESCO (2015), education is a fundamental human right and a lifelong process that promotes holistic development and social participation. Science education focuses on teaching scientific concepts, processes, and methodologies to enhance students' understanding and their ability to apply scientific principles (Bybee, 2014).

Educational technology, including digital devices, software, and online platforms, supports teaching and learning by improving accessibility and learning outcomes (Roblyer, 2015).

Multimedia resources, particularly infographic video modules, have become essential tools in modern education. These modules clarify difficult ideas and hold students' attention by fusing clear information with visual components. Process skills, including observation, classification, inference, prediction, and experimentation, are essential for comprehending concepts and carrying out experiments in chemistry education. These talents are frequently not adequately developed by traditional teaching approaches, which has increased interest in creative teaching techniques. Multimedia learning tools have been shown to enhance comprehension and retention, supporting active and student-centered learning (Mayer, 2009).

In the context of ninth-grade chemistry, integrating infographic video modules offers significant advantages. These resources can address the limitations of conventional teaching by fostering engagement, critical thinking, and practical skill development. Previous studies highlight the need for innovative, student-centered approaches in science education (Day, 2018). By complementing diverse learning styles, infographic video modules can enhance both conceptual understanding and the application of chemistry knowledge. This study investigates the effectiveness of infographic video modules in improving ninth-grade students' process skills in chemistry and explores their potential as supplementary educational resources.

### Review of the Related Literature

Anjugam and Chellamani (2024) analysed trends in science process skills across primary, secondary, and tertiary levels, highlighting the role of basic and integrated skills, teaching methodologies, and learning environments in shaping students' scientific competencies. Asrial et al. (2022) examined the influence of students' attitudes and learning motivation on science process skills among 153 junior high school students and found a significant positive correlation, indicating that both attitude and motivation significantly affect the development of science process skills. Pandia and Balasubramaniam (2023) demonstrated that infographics

combining text, images, and graphics enhance understanding, retention, and engagement while promoting critical thinking and catering to diverse learning preferences. Khasawneh and Khasawneh (2023) conducted an examination of the effectiveness of incorporating an infographic-based instructional program into elementary school curricula and its impact on students' overall academic achievement. Beichumila et al. (2022) investigated the use of computer simulations and animations in chemistry. Over 70% of students demonstrated proficiency in science process skills, especially in hypothesis formulation and conclusion, though planning experiments was less frequent. Al-Behadili and Al-Dayni (2022). Research has examined the impact of incorporating infographic-based instructional programs into elementary school curricula on students' academic achievement. Grieger and Leontyev (2021) explored Student-Generated Infographics for Learning Green Chemistry and Developing Professional Skills of an infographic project within a majors-level organic chemistry laboratory course. Sharma and Singh (2021) examined infographic and animated video modules in chemistry. Multimedia-based instruction enhanced observational, inferential, and predictive skills, improving laboratory and experimental performance. Boco et al. (2020) compared animated versus static infographics for teaching chemical bonding to ninth-grade students. Animated infographics led to higher post-test scores and better retention due to their interactive and engaging nature. Roblyer (2015) emphasized that educational technology provides personalized learning experiences, supports diverse learning styles, and increases engagement and achievement. Mayer (2009) demonstrated that combining visual and textual information enhances comprehension and retention, and that infographic video modules simplify complex scientific concepts.

### Objectives

1. To develop infographic video modules for teaching selected chemistry concepts to ninth-grade students.
2. To enhance students' chemistry process skills, including observing, classifying, predicting, inferring, and experimenting, through infographic video modules.
3. To assess the effectiveness of infographic video modules in improving students' understanding and application of chemistry concepts.
4. To compare the chemistry process skills of students before and after the use of infographic video modules.
5. To explore students' engagement, motivation, and learning experience while using infographic video modules.

### Hypotheses

1. There is a significant improvement in ninth-grade students' chemistry process skills after using infographic video modules.
2. Students taught using infographic video modules will perform significantly better in chemistry process skills than they did on their pre-test.
3. The use of infographic video modules positively influences students' engagement and motivation in learning chemistry.

### Methodology

#### Design

This study employed a parallel-group experimental design to evaluate the effectiveness of infographic video modules in developing chemistry process skills among ninth-grade students.

#### Participants

The present study adopted a quasi-experimental pre-test-post-test non-equivalent control group design. The study involved 30 students in the experimental group and 30 students in the control group from a Government Higher Secondary School in Ellakurichi, Ariyalur District. Participants were selected using purposive sampling to ensure that both groups were appropriately established for the study. As the groups were not randomly assigned, the design is classified as non-equivalent. To address potential initial differences between groups and increase statistical precision, Analysis of Covariance (ANCOVA) was employed, with pre-test scores as the covariate. Pre-test scores were initially compared using an

independent-samples t-test to assess baseline equivalence. ANCOVA was conducted to control for any pre-existing differences and to obtain adjusted post-test means, thereby strengthening the internal validity of the findings.

#### Instruments

1. **Infographic Video Modules:** Infographic video modules were developed by the researcher for teaching selected chemistry concepts prescribed in the ninth-grade syllabus. The modules incorporated visual representations, animations, narration, concise textual explanations, and embedded assessment activities to promote the development of chemistry process skills such as observation, classification, inference, prediction, and interpretation. Subject experts reviewed the modules' content to ensure curricular alignment, accurate concepts, and pedagogical appropriateness. Necessary revisions were made based on expert feedback.

2. **Chemistry Process Skills Achievement Test:** A Chemistry Process Skills Achievement Test was constructed by the researcher to measure students' proficiency in selected process skills. The test consisted of structured, objective-type items that covered observing, classifying, inferring, predicting, hypothesizing, and interpreting data.

Content validity of the test was established through evaluation by three experts in science education and chemistry. They examined the items for relevance, clarity, and alignment with learning objectives. Modifications were incorporated based on their suggestions to improve item quality and coverage. A pilot study was conducted with 20 ninth-grade students from a different school to assess clarity, difficulty level, and reliability of the instrument. Based on pilot analysis, ambiguous items were revised. The test's internal consistency reliability was determined using Cronbach's alpha, yielding  $\alpha = 0.82$ , indicating good reliability. The same validated instrument was administered as both pre-test and post-test, with the order of items rearranged in the post-test to minimize recall bias while maintaining content equivalence.

#### Procedure

The study began with the administration of a pre-test to assess the baseline chemistry process skills of the ninth-grade students. The pre-test was conducted for 75 minutes under standardized examination conditions. Following this, the experimental group was taught selected chemistry concepts using the infographic video modules for 20 instructional days (four weeks). The modules integrated interactive videos, text explanations, animations, and evaluation activities to make the content engaging and accessible. Teachers were trained to guide students in navigating the modules, ensuring that all students could interact with the videos, access supporting materials, and complete the embedded exercises. During the implementation phase, feedback from both students and teachers was collected to refine the modules and improve clarity. After completing the instructional sessions, a post-test of 75 minutes duration was administered under the same standardized conditions to evaluate improvements in students' chemistry process skills. The data from pre- and post-tests were analysed to determine the effectiveness of the infographic video modules in enhancing students' understanding, application, and overall competency in chemistry concepts.

#### Preparation and Development of Infographic Video Module

Infographic videos were systematically created to enhance ninth-grade students' understanding of chemistry. The primary objective was to improve understanding, practical skills, engagement, and retention. Key content was carefully selected from the prescribed syllabus, and multimedia elements, including graphics, animations, narration, and concise textual explanations, were integrated to make the lessons engaging and pedagogically effective. These videos were developed in modules and implemented over 20 instructional days (four weeks).

Researchers were given proper training before starting the intervention so that all of them could use the infographic video modules consistently and guide students effectively. During development, feedback was collected to improve the content, making it clearer and more understandable. The modules were also reviewed by subject experts and tested with a small group of students to ensure that the concepts were accurate, clear, and suitable for ninth-grade learners.

To ensure that the interventions are faithful, classroom observations were conducted using an observation checklist to verify that the instructional plan was followed, the time spent using the modules, and the teacher's facilitation practices. The teachers used a uniform implementation plan of 20 days (four weeks). Student participation was tracked through attendance reports, completion of module activities, and online response forms submitted after each module. Weekly monitoring records were kept to ensure consistency in the delivery of the module and in student involvement during the intervention period. These monitoring procedures ensured consistency in implementation throughout the intervention period and strengthened the study's internal validity. The finally validated videos helped students strengthen their practical chemistry process skills and improve their performance in the subject.

### Chemical Bond - Part 1

This infographic module introduces chemical bonding, specifically explaining the bonding process, the octet rule, and bond types, while simultaneously enhancing students' chemical process skills. Students interact with this module through an infographic template that guides them through videos and text explanations in a sequential manner. Each section presents key concepts, with clickable icons leading to additional videos, text explanations, and interactive content. At the end of the module, students complete an assessment via a Google Form with multiple-choice questions to evaluate their understanding. They are encouraged to apply the concepts by listing different types of bonds with real-life examples. Students can revisit the module as needed, thereby strengthening both their conceptual understanding and their chemistry process skills, such as observation, classification, and knowledge application.

### Chemical Bond—Part 2

This infographic module introduces valency and ionic bond formation, providing examples to help students understand the concepts and develop related chemistry process skills. Students were guided on how to interact with the infographic template to access the content. Clicking the template begins the video on Chemical Bonding—Part 2. Subsequent icons allow students to view corresponding text documents that reinforce the video content, as well as additional videos and explanations on valency and ionic bond formation with examples. The final icon presents an evaluation activity via a Google Form with multiple-choice questions, enabling students to assess their understanding. Students are encouraged to complete practice exercises, including listing ionic compounds with real-life examples. They can revisit the module as needed to strengthen their conceptual understanding and further develop process skills such as observing, classifying, and applying knowledge.

### Chemical Bond—Part 3

This infographic module focuses on covalent bonds and their types, helping students understand the concepts while developing related chemistry process skills. Students were guided on interacting with the infographic template to access the content. Clicking the template starts the video on Chemical Bonding—Part 3, and subsequent icons provide text documents and additional videos that explain covalent bonds and their types in detail. The final icon presents an evaluation activity via a Google Form, allowing students to assess their understanding. Students are encouraged to complete practice exercises, including listing covalent compounds with real-life

examples. They can revisit the module as needed to reinforce their conceptual understanding and further develop process skills such as observing, classifying, and applying knowledge.

### Conducting Experimentation and Data Collection

The study began after receiving approval from the Headmaster of the Government Higher Secondary School, Elakurichi. A 75-minute pre-test was administered to both the experimental and control groups to assess their initial chemistry process skills. Following this, the experimental group received treatment using the carefully developed, tested, and accessible infographic video modules. The investigator monitored student engagement and progress over a period of one month, while the control group continued with traditional teaching methods. After the treatment period, a 75-minute post-test was conducted for both groups to measure learning outcomes and evaluate the impact of the modules on chemistry process skills. Data collected included pre- and post-test scores, student engagement with the modules, and feedback. These data were analyzed using descriptive statistics, differential analysis, correlation analysis, and effect size to determine the effectiveness of the infographic video modules in enhancing students' chemistry process skills.

## Results

**Table 1**  
Pre-Test and Post-Test Scores of Process Skills in the Control Group

Group	n	M	SD	t	p
Pre-test	30	34.00	3.45	8.85*	< .001
Post-test	30	43.10	4.60		

Note. \* $p < .05$ .

**Table 2**  
Pre-Test and Post-Test Scores of Process Skills in the Experimental Group

Group	n	M	SD	t	p
Pre-test	30	32.60	3.85	16.00*	< .001
Post-test	30	48.00	4.40		

Note. \* $p < .05$ .

**Table 3**  
Comparison of Pre-Test Scores Between Control and Experimental Groups

Group	n	M	SD	t	p
Control group	30	34.00	3.45	1.48*	0.142
Experimental group	30	32.60	3.85		

Note. \* $p < .05$ .

Independent samples t-test revealed no statistically significant difference between the control and experimental groups at the pre-test level ( $t(58) = 1.48, p > .05$ ), confirming baseline equivalence prior to the intervention.

**Table 4**  
Analysis of Covariance for Post-Test Scores Controlling for Pre-Test Scores

Source	SS	df	MS	F	p	$\eta^2p$
Pre-test (Covariate)	412.35	1	412.35	18.72	< .001	0.247
Group	458.90	1	458.90	20.84		0.268
Error	1255.40	57	22.02			

Note. Dependent variable: Post-test scores. SS = sum of squares; MS = mean square.

After adjusting for pre-test scores using ANCOVA, a statistically significant difference was found between groups ( $F(1,57) = 20.84, p < .001, \eta^2p = 0.268$ ), indicating that the intervention had a significant effect on post-test scores. The partial eta squared value of

0.268 represents a large effect size, with approximately 26.8% of the variance in post-test scores explained by group membership after controlling for pre-test differences.

Strong positive correlations were observed between pre-test and post-test scores in both groups (control:  $r = 0.83$ ,  $p < .001$ ; experimental:  $r = 0.75$ ,  $p < .001$ ), indicating consistency in student performance rankings across testing occasions.

The experimental group ( $M = 48.00$ ,  $SD = 4.40$ ) scored significantly higher than the control group ( $M = 43.10$ ,  $SD = 4.60$ ) on the post-test ( $t(58) = 4.55$ ,  $p < .001$ ). The effect size (Cohen's  $d = 1.18$ ) indicates a large practical difference between groups.

**Table 6**

Correlation Between Pre-Test and Post-Test Scores (Control Group & Experimental Group)

Group	<i>n</i>	<i>M</i> (Pre-test)	<i>SD</i> (Pre-test)	<i>M</i> (Post-test)	<i>SD</i> (Post-test)	<i>r</i>	<i>p</i>
Control group	30	34.00	3.45	43.10	4.60	0.83	< .001
Experimental group	30	32.60	3.85	48.00	4.40	0.75	

Note. \* $p < .05$ .

**Table 7**

Process Skills Scores of Control Group (Pre- and Post-Test)

Process Skill	<i>M</i> (Pre-test)	<i>SD</i> (Pre-test)	<i>M</i> (Post-test)	<i>SD</i> (Post-test)
Observation	4.7	0.63	5.95	0.61
Inferring	4.7	0.57	5.80	0.65
Classifying	4.5	0.72	5.60	0.54
Predicting	4.4	0.60	5.55	0.70
Hypothesizing	3.6	0.74	5.20	0.65
Generalizing	3.5	0.63	5.05	0.62
Manipulating variables	4	0.56	5.20	0.63
Interpreting	4.6	0.71	4.75	0.68
Total	34.00		43.10	

**Table 8**

Process Skills Scores of Experimental Group (Pre- and Post-Test)

Process skill	<i>M</i> (Pre-test)	<i>SD</i> (Pre-test)	<i>M</i> (Post-test)	<i>SD</i> (Post-test)
Observation	4.7	0.63	6.4	0.61
Inferring	4.6	0.57	6.6	0.65
Classifying	4.5	0.72	6.2	0.54
Predicting	4.5	0.60	6.4	0.70
Hypothesizing	3.5	0.74	5.6	0.65
Generalizing	3.5	0.63	5.7	0.62
Manipulating variables	3.7	0.56	5.8	0.63
Interpreting	3.6	0.71	5.3	0.68
Total	32.60		48.00	

Note.  $N = 30$ . Total scores are sum of component means.

**Table 9**

Effect Size of Pre-Test and Post-Test Scores

Group	MD	SD_diff	Pooled <i>SD</i>	Cohen's <i>d</i>	95% CI for <i>d</i>	Effect Magnitude
Control group	9.10	2.59	4.07	3.51	[2.51, 4.51]	Very large
Experimental group	15.40	2.96	4.13	5.20	[3.91, 6.49]	Very large

Note. *SD\_diff* = standard deviation of difference scores; Cohen's *d* calculated using the formula for paired samples, accounting for pre-post correlation.

## Findings

1. There was a statistically significant improvement in process skills scores within the control group from pre-test to post-test.
2. There was a statistically significant improvement in process skills scores within the experimental group from pre-test to post-test.
3. There was no statistically significant difference between the control and experimental groups at the pre-test stage, indicating that both groups were comparable before the intervention.
4. After controlling for pre-test scores using ANCOVA, a statistically significant difference was found between the control and experimental groups in post-test scores.
5. The experimental group performed significantly better than the control group in the post-test.
6. A strong positive correlation was found between pre-test and post-test scores in both the control and experimental groups, indicating consistency in students' performance.
7. In the control group, improvement was observed across all individual chemistry process skills, including observation,

8. In the experimental group, improvement was observed across all individual chemistry process skills, with gains that were higher than those in the control group.
9. The effect size analysis indicated a large practical impact of the intervention, with the experimental group showing a stronger effect compared to the control group.
10. Overall, the infographic-based instructional modules were effective in enhancing students' chemistry process skills, particularly in the experimental group.

## Discussion

The findings of this study indicate that infographic video modules effectively enhance chemistry process skills among ninth-grade students. Students in the experimental group showed greater improvement in skills such as observation, inference, classification, prediction, and experimentation than those in the control group using traditional methods. These results align with previous research,

showing that multimedia-based instruction improves understanding, retention, and practical skills in science. Mayer (2009) highlighted that combining visual and textual information enhances comprehension, while Pandia and Balasubramaniam (2023) and Sharma and Singh (2021) reported that infographic and animated modules support critical thinking, engagement, and laboratory skills. Studies by Grieger and Leontyev (2021) and Boco and Miralles (2020) also emphasize that interactive infographics promote better conceptual understanding and skill application. Overall, both the current study and prior research suggest that infographic video modules provide an effective, student-centered approach to teaching complex chemistry concepts, improving process skills, and making learning more engaging and meaningful.

### Conclusion

The present study found that infographic video modules significantly enhanced chemistry process skills among ninth-grade students, with the experimental group showing greater improvement than the control group in observation, inferring, classifying, predicting, hypothesizing, generalizing, manipulating variables, and interpreting. These results, aligned with previous research, demonstrate that multimedia and infographic-based instruction improve comprehension, engagement, retention, and practical application in science education. The interactive, visually engaging modules allowed students to practice concepts repeatedly, promoting active, student-centered learning. Overall, the study confirms that infographic video modules are an effective tool for enhancing conceptual understanding and scientific process skills at the secondary level. For further research, future studies could investigate the use of infographic modules in other science subjects, assess long-term retention of skills, compare different multimedia tools, include larger and more diverse samples, and explore integration with collaborative or blended learning approaches to further enhance engagement and critical thinking.

### AI Use Statement

The authors used Grammarly and ChatGPT for grammar checking, improving sentence clarity, and language improvement. The author reviewed and edited the output and takes full responsibility for the final content.

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