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Self-Learning Modules and Academic Motivation in Chemistry

Sankar E[1] & Professor Dr. A. Edward William Benjamin[2]

1. Research Scholar, Bharathidasan University, Tiruchirappalli, Tamil Nadu, E-mail: sankarjan1984@gmail.com
2. Professor, Department of Education, Bharathidasan University, Tiruchirappalli, Tamil Nadu

Abstract:

This study utilized an experimental design to examine the influence of self-learning modules on academic motivation in chemistry. A total of 40 higher secondary students in the XI grade were randomly selected and divided into two groups: a control group and an experimental group, each consisting of 20 students. Before the intervention, a short version of the academic motivation scale was administered to both the experimental and the control groups. The self-learning modules were introduced exclusively to the experimental group over 12 consecutive weeks. Following the intervention, the academic motivation scale was administered again. Analysis of the pre-test and post-test results indicated a significant improvement in the academic motivation of the students who participated in the self-learning modules. The study recommends conducting a longitudinal study to further assess the effectiveness of the self-learning modules and suggests implementing constant feedback to enhance their efficacy.

Keywords: *Modules, XI Standard Students, Quasi-Experiment, and Achievement in Chemistry.*

Introduction

Education plays a crucial role in shaping students' learning outcomes and motivation, with instructional strategies being a significant factor. Academic motivation is a key psychological concept that affects students' engagement, persistence, and success in learning (Ryan & Deci, 2020). Chemistry, known for its complexity, often requires innovative teaching methods to ignite student interest and motivation. One effective approach that has gained popularity is the use of self-learning modules, which allow students to learn at their own pace and according to their individual preferences (Aljraiwi, 2019).

Self-learning modules are instructional tools designed to promote independent learning by breaking down complex topics into manageable and interactive units (Hussain et al., 2022). These modules include various components such as problem-solving activities, real-world applications, and immediate feedback, which enable students to actively construct their knowledge. This approach is particularly effective in subjects like chemistry, where a strong conceptual understanding is essential. Research has shown that self-learning modules can enhance students' intrinsic motivation and engagement (Law et al., 2021).

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Previous studies have shown that active learning strategies, like self-learning modules, can significantly enhance academic motivation and achievement (Kang et al., 2020). These modules not only cater to the diverse needs of learners but also promote self-regulation, which is an essential aspect of academic motivation (Zimmerman, 2002). Additionally, incorporating these modules into quasi-experimental designs enables a more thorough evaluation of their effectiveness in actual educational settings.

This study examines the impact of self-learning modules on academic motivation among higher-secondary chemistry students. Using a quasi-experimental design with pre- and post-intervention assessments, the research aims to determine whether self-learning modules can effectively enhance students' academic motivation. This investigation contributes to the increasing body of literature supporting student-centered and innovative teaching strategies in STEM education.

Review of Literature

Academic motivation is essential for students' learning outcomes and engagement. Both intrinsic and extrinsic motivation are positively related to student engagement, while amotivation has a negative impact (Kotera et al., 2021). Research by Kryshko et al. (2021) has shown that self-efficacy in motivational regulation can positively predict students' satisfaction with study content and their ability to cope with study-related stress. This indicates that fostering students' self-efficacy could enhance their motivation when it comes to self-learning modules.

Interestingly, the readiness for self-directed learning (SDL) is significantly influenced by intrinsic motivation. Students who exhibit higher levels of intrinsic motivation tend to engage more proactively in SDL (Grande et al., 2022). This suggests that fostering intrinsic motivation is crucial for the success of self-learning modules in chemistry. Furthermore, self-efficacy, academic motivation, and self-regulation are key factors that contribute to students' learning success. However, the interrelationships among these factors in predicting learning outcomes can vary across different learning environments (Zheng et al., 2020).

There is currently no specific information available on self-learning modules in chemistry. However, research suggests that enhancing students' intrinsic motivation, self-efficacy, and self-regulation skills could improve their engagement and success with these modules. Further research focused specifically on chemistry education and self-learning modules is necessary to draw more precise conclusions.

Objectives of the study

The primary objective of this study is to examine the influence of self-learning modules on the academic motivation of higher secondary students in chemistry. Specifically, the study aims to:

1. Assess the initial academic motivation levels of XI standard students using a standardized academic motivation scale.
2. Implement self-learning modules as an intervention for a duration of 12 weeks to enhance academic motivation in chemistry.
3. Compare the pre-test and post-test scores to evaluate the effectiveness of self-learning modules on academic motivation.

Hypothesis of the Study

There is no significant difference between the pre-test and post-test scores of academic motivations among XI standard students after the intervention of self-learning modules.

Method

Research Design

This study utilized an experimental design featuring pre-test and post-test measures to explore the impact of self-learning modules on academic motivation in chemistry among higher secondary students. This approach allowed for the assessment of changes in academic motivation before and after the intervention. The research involved a sample of 40 students in the XI standard from a single educational institution. Participants were selected through purposive sampling to ensure suitability for evaluating the effectiveness of the self-learning modules in chemistry. They were then randomly assigned to either the experimental group or the control group.

To measure the students' levels of motivation, the study employed the Short Version of the Academic Motivation Scale (SAMS). This scale has 14 items with the dimensions namely: Intrinsic Motivation to Know, Intrinsic Motivation toward Accomplishment, Intrinsic Motivation to Experience Stimulation, Identified Regulation, Introjected Regulation, External Regulation, and Amotivation, with high validity and reliability (Kotera et al., 2021).

At the outset, the Academic Motivation Scale was administered to all participants to measure their baseline levels of motivation in chemistry and the pre-test scores were collected and then the experimental group was provided with 12 week self-learning modules in chemistry.

12-Week Intervention Model: Self-Learning Modules in Chemistry

Objectives of the Intervention

1. To enable students to understand the fundamental concepts of hydrogen and alkali/alkaline earth metals.
2. To enhance academic motivation and foster independent learning in chemistry.

Weekly Plan

Week	Self -Learning Module	Activity
1	Orientation and Introduction	Teaching Physical and Chemical properties of hydrogen using PDFs, Videos, and activity sheets.
2	Occurrence and preparation of Hydrogen	Videos, worksheets, and Quiz
3	Properties and uses of Hydrogen	Experimental Demonstrations, case studies, and assignment
4	Introduction to Alkali Metals	Module content, Diagram study, and practice problems
5	Reactions and uses of Alkali Metals	Experiments, mind mapping, and online Quiz
6	Alkaline Earth Metals	Module content, Group activity, and worksheet
7	Reactions and applications of Alkaline Earth Metals	Experiment, Role Play and Assignment
8	Compounds of Hydrogen	Diagram Study, group discussion and practice problem

9	Compounds of Alkali Metals	Module content, experiment and quiz
10	Compounds of Alkaline Earth Metals	Module content, video, and worksheet
11	Consolidation and revision	Interactive Q & A session, concept mapping, and practice test
12	Assessment and Feedback	Post-test, peer review and feedback

After the 12-week intervention, the Academic Motivation Scale was administered again to measure changes in the student's motivation levels. The pre-test and post-test scores were analyzed using paired sample t-tests to assess the statistical significance of the differences in academic motivation before and after the intervention. Effect size calculations were conducted to quantify the magnitude of the changes observed. Informed consent was obtained from all participants and their guardians before the study. Throughout the research process, we ensured the anonymity and confidentiality of the participant's data.

Results

1. Descriptive statistics

	Pre -Test		**Post-test**	
	Control group	**Experimental group**	**Control group**	**Experimental group**
Mean	**28.850**	**29.400**	**28.950**	**35.450**
Std. Deviation	**8.054**	**7.816**	**7.950**	**5.799**
Minimum	**18.000**	**20.000**	**19.000**	**25.000**
Maximum	**50.000**	**50.000**	**50.000**	**60.000**

Descriptive statistics were calculated to examine the pre-test and post-test scores for the control and experimental groups. For the pre-test, the control group had a mean score of M=28.85M = 28.85M=28.85, SD=8.05SD = 8.05SD=8.05, with scores ranging from 18 to 50. The experimental group had a mean score of M=29.40M = 29.40 M=29.40, SD=7.82SD = 7.82SD=7.82, with scores ranging from 20 to 50.

For the post-test, the control group had a mean score of M=28.95M = 28.95 M=28.95, SD=7.95SD = 7.95SD=7.95, with scores ranging from 19 to 50. The experimental group had a mean score of M=35.45M = 35.45 M=35.45, SD=5.80SD = 5.80SD=5.80, with scores ranging from 25 to 60.

These results indicate that while the control group's mean scores remained relatively stable between the pre-test and post-test, the experimental group demonstrated a notable increase in mean scores from the pre-test to the post-test. This suggests the potential effectiveness of the intervention implemented in the experimental group.

2. Paired t-test

	T	df	p
Post-test pre-test of the experimental group	2.954	38	0.005
Post-test pre-test of Control group	0.789	38	NS

A paired-sample t-test was conducted to compare the experimental group's post-test and pre-test scores. The results indicated a statistically significant difference between the post-test (M = [insert mean], SD = [insert standard deviation]) and pre-test (M = [insert mean], SD = [insert standard deviation]), t(38)=2.95,p=. 005 t (38) = 2.95, p = .005 t (38) = 2.95, p=.005. This suggests that the experimental intervention had a significant impact on the scores. While the control group did not show any significant changes.

Discussions:

No specific study using an experimental design directly examines the influence of self-learning modules on academic motivation in chemistry. However, some relevant information can be extracted from previous studies. A study (Bascuñana et al., 2023) describes the implementation of Jupyter Notebooks (JNs) in a Chemical Engineering module to enhance student learning. While not specifically focused on motivation, the study found that this innovative teaching approach using interactive JN activities successfully promoted student motivation and learning experience (Bascuñana et al., 2023). Another study discussed (Lapitan et al., 2023) discussed the implementation of flipped classrooms and collaborative learning in Analytical Chemistry during remote instruction. Although not an experimental design, the study found that these active learning methods positively impacted students' comprehension of concepts and calculations. Students reported that pre-recorded videos were important for self-paced learning, which could be considered a form of self-learning module (Lapitan et al., 2023). It's worth noting that (Leino et al., 2024), while not focused on chemistry, found that the use of virtual learning environment (VLE) activities, including optional online tests, was an important predictor of academic achievement in psychology education. These studies suggested that self-learning modules in digital formats can potentially influence academic performance (Leino et al., 2024).

Educational Implications

1. Curriculum Design: Educators and curriculum developers should consider incorporating self-learning modules into chemistry courses to enhance student motivation and engagement.
2. Diverse Learning Materials: Offering both printed and electronic modules can cater to different learning preferences and increase accessibility for students.
3. Skill Development: The use of learning modules can be extended to focus on specific skill areas within chemistry education, promoting targeted improvement in student competencies.
4. Self-Efficacy Enhancement: Incorporating strategies within the modules to boost student self-efficacy may lead to increased confidence and motivation in chemistry learning.
5. Long-term Implementation: Schools and educational institutions should consider long-term implementation of modular learning approaches to sustain improvements in academic motivation and learning outcomes.

6. Teacher Training: Professional development programs for chemistry teachers should include training on effectively utilizing and creating self-learning modules to support student motivation and learning.
7. Personalized Learning: The modular approach allows for more personalized learning experiences, which can be further explored to address individual student needs and learning paces.
8. Assessment Strategies: Developing assessment methods that align with the modular learning approach may provide more accurate insights into student progress and motivation levels.

Limitations:

1. **Sample Size:** The study was conducted with a relatively small sample of 50 students, which may limit the generalizability of the findings.
2. **Duration:** The 12-week intervention may not capture long-term changes in academic motivation, necessitating follow-up studies to examine sustained effects.
3. **Measurement Tool:** The reliance on self-reported academic motivation scales may introduce response bias, as students might overestimate or underestimate their motivation.
4. **Contextual Factors:** The study was conducted in a specific educational and cultural context, which might influence the applicability of the results in other regions or settings.

Conclusion:

The findings of this study highlight the positive impact of self-learning modules on academic motivation in chemistry among higher secondary students. The quasi-experimental design facilitated a detailed examination of changes in students' motivation over a 12-week intervention period. A significant improvement in post-test scores compared to pre-test scores underscores the effectiveness of self-learning modules in enhancing academic motivation. These results align with previous studies, which emphasize the importance of student-centered learning approaches, particularly in STEM education (Law et al., 2021). The modules not only promoted a deeper engagement with chemistry but also fostered self-regulated learning, a critical factor in sustained academic motivation (Ryan & Deci, 2020).

This study contributes to the growing body of literature supporting innovative teaching methodologies and underscores the potential of self-learning modules in improving academic outcomes. However, further research with larger and more diverse samples is needed to generalize these findings.

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