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STUDYING THE IMPACT OF E-MODULES AND ONLINE SELF-DIRECTED LEARNING OF CHEMISTRY AT THE HIGHER SECONDARY LEVEL

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ABSTRACT

Teachers' mastery of learning technologies is highly necessary for the digital era. Among such skills is the ability of teachers to package learning materials using various software. One form of presenting learning materials with technology is an e-module. E-modules serve as the main teaching material in online learning and can also be used in face-to-face learning.There are many studies conducted in a variety of learning methods, but the overall impact related to the use of e-modules is still lacking. Therefore, this study aims to examine the impact of the use of e-modules in learning and facilitation.The questionnaire data are collected from 549 higher secondary school students. This study aims to analyze the effectiveness and impact of self-directed learning-based e-modules in improving higher secondary school students to improve their learning performance in chemistry subject. The purpose of this study was to analyze the effects of using e-modules on students' attitudes, students' interests, students' retention levels, and student's learning outcomes in an online learning environment. This research used a quasi-experimental research design with a nonrandomized control-group pretest-posttest design. This study examines efficiency towards the learners' attitude and performance. Multiple representations integrated with learning materials in the e-modules helped students understand chemistry concepts. The ordered stages of guided discovery learning integrated with complete and interactive multimedia in the e-modules facilitated students to engage in learning, investigating, and evaluating information to conclude; the attempts to train higher-order retention level. It predicted that self-learning modules are more effective than conventional modes. Therefore, it can be demonstrated that guided discovery learning-based chemistry e-module can effectively improve higher secondary school students learning outcomes. Consequently, this study, makes it easier for students to connect between levels of retention and attitude of each concept with self-learning or E-modules. In addition to increasing students' skills, applying modules in learning from both printed and electronic modules can improve learning outcomes, performance, and interest of students in learning chemistry.

Keywords: E-Modules, Self-Learning Modules, Higher Secondary Students,Quasi-Experimental Design, Descriptive-Correlational Research, Learners' Attitude and Learners' Performance

1. INTRODUCTION

Students today live in a diverse, interconnected, and undergoing rapid change world. Young people's lives are shaped by economic, social, cultural, digital, demographic, environmental, and epidemiological forces, and they encounter previously unheard-of opportunities and challenges [1].Learning chemistry can be challenging due to the nature of chemistry. The most significant subject that aids pupils in understanding their environment is chemistry [2].It has been generally noted that chemistry is a crucial topic for education and that it is crucial for any country's advancement in science and technology [3].According to reports, pupils' prior experience in integrated science has a causal impact on their chemistry performance [4]. Without providing some experience in integrated science, a student cannot learn chemistry properly. It has been noted that the quality of the lab, a component of the educational setting, has an impact on student's performance in chemistry classes [5]. The study will provide further insight into the connections between student, teacher, and school environment-related variables of interest and student achievement in chemistry [6].

E-modules serve as the main teaching material in online learning and can also be used in face-to-face learning. The purpose of this study was to analyse the effects of using e-modules on self-efficacy, motivation, and learning outcomes in an online learning environment [7]. Three pretest-posttest groups were used in this quasi-experimental study. The three student groups used in this study were the control group (Group A), the experimental group (Group B), and the experimental group (Group C), all of which did not use e-modules [8]. E-modules are used to improve learning outcomes, motivation, and self-efficacy. The most successful e-modules were those featuring the collaborative learning option [9]. Much emphasis has been paid to the study of online learning by academics and practitioners, particularly those working in higher education institutions [10]. Many studies have explored the benefits of online learning such as convenience and flexibility as well as its challenges including technical difficulties, lack of a sense of community, and delayed communication [11]. The study's conclusion examines the effects of online self-directed learning in chemistry at the higher secondary level using e-modules [12]. To increase student success in the subject, it is anticipated that the study's findings will encourage the stakeholders to improve the single variables that have been identified to have a direct causal relationship with student achievement in chemistry [13]. The core of learning for all disciplines, including chemistry, is a variety of abstract notions that are combined in most curricula [14]. The investigation discovered misunderstandings, including learning to memorise and specific sections of fundamental chemistry that they have not grasped at each level, although the students provide numerous examples of their learning and comprehension in their answer sheets [15]. This research used a quasi-experimental method with three groups of pretest-posttest research design. As a result, the method used to examine the effects of online self-directed learning in chemistry at the higher secondary level. The findings of this research are hoped to contribute to the study of effective instructional strategies in chemistry learning. The rest of the work is organized as follows, section 2 portrays the literature survey of the study, and section 3 exhibits the problem definition and motivation of the research. Section 4 illustrates the proposed research methodology, section 5 elucidated the experimentation and result discussion, and section 6 exposes the research conclusion.

2. LITERATURE SURVEY

Lau *et al* [16] showed that Chemistry lab training frequently falls short of its potential. The theory-laboratory disconnect may be made worse by the scheduling practice used in higher education (HE), which divides theory lessons and practical work into temporally separate sessions. The chemical skill set is not equally impacted by the block schedule, which leaves room for more study on the subject. Abbood*et al* [17] displayed the impact of a training programme based on interactive teaching methods on fourth-grade students' chemistry achievement and capacity for original problem-solving. The t-test for two independent samples revealed a statistically significant difference in favour of the average scores of the students who applied to the training programme based on interactive teaching strategies at the level (0.05), according to the results. Nzomo*et al* [18] discussed how students' self-efficacy in Chemistry is improved by inquiry-based learning in practical Chemistry sessions. A high positive link between inquiry-based learning and students' self-efficacy in Chemistry was found by correlation and regression analysis $(r = 0.903, p = 0.05, R^2 = 0.8155)$.Wahyudiati*et al* [19] analysed the relationship between Sasak and Java local knowledge and chemistry, as well as their potential as a learning resource in introductory chemistry courses. The relevance of Sasak and Java local wisdom with basic chemistry material can be reviewed based on the perspective or analogy approach, representation, and visualisation. Rahman *et al* [20] proposed the Student learning results, student motivation, the connection between motivation and learning outcomes, and student reactions to the usage of chemistry e-modules in the study of carbon and silicon in non-metal inorganic chemistry. Student learning results were significantly improved by the chemistry e-modules. It shows that students' pre-test average was 42.2, their post-test average was 83.4, and their average N-gain value was 0.724 in the high N-gain group.

Nahlik*et al* [21] explored how the Lead Teacher Programme of Beyond Benign has helped a group of practising teachers in the US and Canada to grow their vocabulary and comprehension of green chemistry. A framework for green chemistry instruction at the K–12 level has been constructed using the classroom observations and case studies of four teachers. Thirraja*et al* [22] examined the effect of e-module use on facilitation and learning. The goals of the study were met using a methodical review of the literature. The investigation discovered that there are more than 300 connected papers the results of the study and survey revealed that the use of e-modules had an impact on learning and facilitation. Herlina*et al* [23] developed a legitimate, useful, and efficient electronic module based on guided inquiry on the subject matter of Newton's law of gravity. The guided inquiry-based e-module on Newton's law of gravity is said to be valid, useful, and helpful for developing critical thinking abilities based on the examination of the research findings. Pimdee, *et al* [24] investigated the Thai student-teacher self-directed learning (SDL) competencies in three areas. The SDL competency for self-control (SC) (0.96) was the one that the student teachers valued the most, according to analysis from the second-order CFAs. However, they lagged somewhat in terms of learning desire (LD) (0.87) and self-management (SM) (0.80) abilities.Thembane*et al* [25] explained the purpose of this study was to evaluate how the students felt about the use of an online quiz as part of a bigger plan to enhance the teaching and learning of the subject. The impact of assessment in the medical sciences field on certification with regulatory bodies, certification throughput rates, university reputation and government funding for the university made this study crucial.

3. RESEARCH PROBLEM DEFINITION AND MOTIVATION

The most crucial subject that helps studentsto understand their surroundings is represented as chemistry. The relevance of chemistry in the scientific and technological advancement of any country has been noted as a highly important educational subject. Without providing some experience in integrated science, a student cannot learn chemistry properly. Students have trouble learning chemistry because of the concepts that are focused on or connected to material structure. The degree of anxiety that students experience affects their academic performance in chemistry. Other elements, like those at school and in the classroom, affect student progress. For online learning, E-modules are the primary teaching tool and in face-to-face learning, theyalso can be utilised. Self-efficacy, motivation, and learning outcomes in an online learning environment as a result of employing e-modules. Students' critical thinking, problem-solving, and scientific process skills are enhanced by the development of problem-based learning E-modules. But it's also crucial to comprehend student characteristics and how they affect what happens in online learning environments. Researchers have observed particular characteristics, such as prior knowledge, time management, and gender disparities.

As a chemistry teacher and researcher noticed that students are afraid of learning chemistry and are reluctant to talk to their teachers in front of the class, and students prefer to feel nervous. Even if they don't comprehend certain concepts, students will choose not to speak during the lesson and refrain from clarifying their doubts or asking questions. The poor performance of students in certain important subjects, particularly the comprehension of ideas like drafting chemical formulae and equations and performing calculations from them, ideas of chemical reaction equilibrium, and ideas of mole concepts, among others. According to some authors, inefficient teaching methods and teaching tools, along with a negative attitude towards studying and teaching chemistry, are to blame for students' poor performance in chemistry. In chemistry classes, the majority of lecturers use rote learning, which bores pupils and causes them to start feeling unfavourable towards the topic. One of the most important aspects of science education is helping students establish positive attitudes towards chemistry since attitudes have a big impact on learning. There is a need for research on the development of online modules that focus on the issue of increasing student knowledge. This research changes from traditional learning environments to online learning environments to better understand the knowledge base around self-directed learning and current engineering educational research.

4. PROPOSED RESEARCH METHODOLOGY

Nowadays modules can transcend individual preferences in learning chemistry in addition to having an impact on students' learning results in the form of conceptual understanding. In the current study, an effort was made to start a sort of learning module that was carefully designed together with a teaching strategy to combat the issue of individual students' low interest in science education and the necessity to inspire classroom practises. In addition to stimulating student self-directed learning and enhancing the role of intrinsic motivation in students' classroom experiences, such modules are expected to explicitly meet students' demands for competence and linkages. The study's goal was to examine the student's use of interactive e-modules and online self-directed learning resources for self-learning.

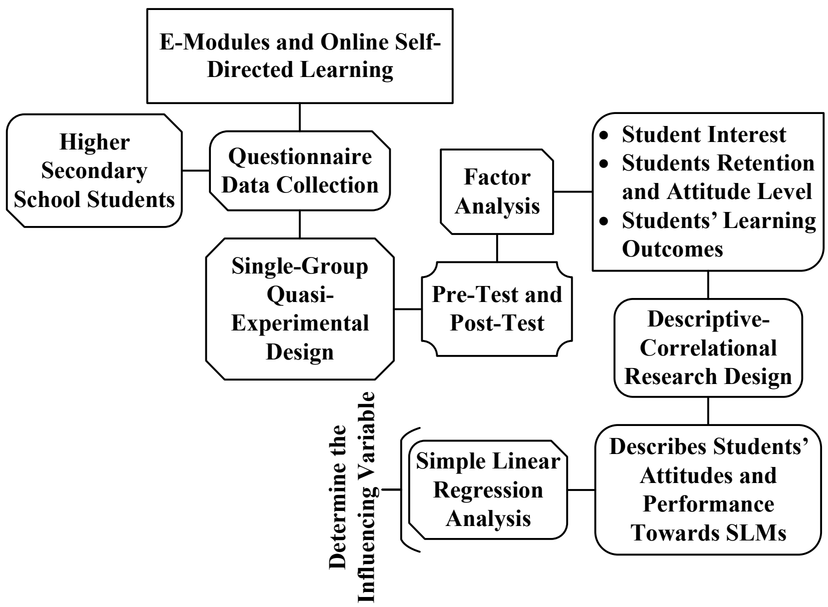

Figure 1: Block Diagram of the Proposed Research Methodology

Figure 1 depicts the block diagram of the research work. Here, two tools that were developed by the researchers and whose content was validated were employed for the experimental study. The three tools were generated and their information was validated using the same process. On participants from higher secondary school students, a pre-test post-test single-group quasi-experimental design was tested and tried. The pupils' behaviour, intelligence, and other characteristics were believed to be similar and to follow a normal distribution. This study investigated the efficiency towards the learners' attitudes and performance. The study specifically discussed the learner profile, as well as their attitudes towards and performance of SLMs. The study used a descriptive-correlational research approach with participants from higher secondary schools who were not randomly selected. The learners' performance was assessed using their GWA (general weighted average), and their profiles and attitude were collected by a survey questionnaire. The researcher utilizes a simple linear regression analysis technique to identify the influencing variable.

Objectives: The objective of the study is as follows.

- To identify the achievement through self-learning modules in higher secondary students.
- To find out the retention and attitude level in self-learning modules in higher secondary students.
- To determine whether self-learning modules are more effective than conventional modes.
- To determine student interest in learning chemistry courses online in self-learning modules.
- The significant effect of e-module on improving students' learning outcomes.

(a) Data Collection

Data are first gathered from higher secondary school students who are learning chemistry, the parents, and the participants requesting permission to conduct the study. After the request was granted, the researchers employed a survey questionnaire to gather the required information. The learner's profile was questioned in the instrument's first section, which included questions on the learner's age, gender, education level, and employment status. The second component was a checklist with 5 sets of items that included the functions of the self-learning modules (SLM), the student's interest in learning chemistry (SI), the learner's attitude level (LAL) towards e-modules, the learner's retention level (LRL), and the learning outcome (LO) for chemistry study. There are overall 549 students studying chemistry. A substantial association between the students' self-learning module and (a) their interest, (b) their attitude level, and (c) their learning outcome was determined using Spearman's rank correlation coefficient (r_s).

Positive categories on a Likert scale are used to examine the collected data. The scale (0-100) derived from the validation end value (1) is used to analyse it.

$$V = \frac{X}{Y} \times 100\% \qquad (1)$$

Where, V is the percentage of the score earned, X is the score earned, and Y is the highest possible score. During the evaluation of validity, applicability, and effectiveness, this final value is referred to at this interval.

(i) Participants and Sampling Procedure

The random sampling techniques are thought to be appropriate for the context of quantitative research, that is used in this study. The study's participants were chemistry students in higher secondary schools. There are 549 participants were collected based on accessibility and convenient sampling. With the permission and support of their parents and teachers, these students voluntarily participated in the survey. These participants were selected because they were the first group of students to participate in modular learning the previous academic year and struggled to adjust to life in high school.

Table 1: Demographic Profile

Demographic Details		Participants	Total
Age	15	121	549

	16	245	
	17	183	
Gender	Male	298	549
	Female	251	
Grade	11^{th}	234	549
	12^{th}	315	

In table 1, the demographic profile is displayed. The entire student population of 549 from higher secondary schools, which consistsof 11th and 12th graders, served as the study's target demographic. 549 students total, including 251 females and 298 boys from various higher secondary schools, made up the study at that time. Cluster sampling was used to choose the sample of 549 students from 10 intact classrooms with day pupils as the inclusion criterion. Ten clusters from ten-day schools were split into experimental and control groups, respectively. The pupils here must be between the ages of 15 and 17. In total, 121 pupils are 15 years old, 245 are 16 years old, and 183 are 17 years old. However, 234 of the students are from the 11^{th} standard, and 315 are from the 12^{th}. The five clusters of each group were distributed based on the students' academic results in the national examinations.

(ii) Construction and Validation of Research Instrument

The questionnaire was made to draw heavily from the researcher's extensive study of numerous studies, works of literature, and other examples of questionnaires. With cooperation from the subject matter specialists and a research associate, the researcher generated the questionnaire's original draught. Each item was developed based on the concept and validated by subject-matter experts. It was amended in terms of content, format, and structure, and then sent to three experts with expertise in education and research for validation and reliability. After the questionnaire was submitted for content validation, a small change was made. To assess the reliability of the questionnaire, the researcher measured the internal consistency of the survey using the Cronbach alpha statistics. Accuracy and the subject's response to the questions' stimuli were also included.

(b) Research Methodology

Quantitative research was used in this study. It used a descriptive-correlational research design in particular to assess secondary teachers' motivation for writing, research aptitude, and opinions on the elements, scope, and importance of action research. By using this strategy, you can save time, make it easier for respondents, cost saving, collect data more quickly, and use respondents as a group. The selected people explicitly distributed and responded to a survey form. With questionnaires, researchers can help respondents with their responses while also conserving money. For pre-test and post-test analyses, a single-group quasi-experimental design is generated. The completeness of the material, media, and language is validated during the production of e-modules. The assessment/response poll results from product validation and test are the data used in quantitative analysis.

A poll sheet was utilized as the research instrument to evaluate the validity, usability, and efficacy of e-modules. Before use, the validator validates all instruments. Five people consisting of two material validators, two media validators, and one language validator are validated by a validator. Two lecturers who are experts in chemical materials evaluate the material component. This component is evaluated based on the material viability of the E-module chemistry using "Construct 2". Two lecturers who are professionals in media evaluate the media component, which is based on the viability of media from the e-module Physics utilising “Construct 2”. One instructor, an Indonesian linguist, judges the linguistic component. This component is evaluated by language and punctuation used in the E-module physics using "Construct 2". This test makes use of a Likert scale with five possible responses. Researchers developed and have other technologies, like student self-learning modules and chemistry learning outcomes, validated by experts. The information from the outcomes of the student learning independence survey will be supported by these two instruments.

(i) Interactive E-Module

The developed e-modules are suitable for educational usage and have been proven effective in raising students' levels of autonomy and the learning results they attain. This e-module was made to help students better comprehend and use 3D home design software. This e-module was a website that the user could access and see without an internet connection (offline), or they could use a flash drive to copy it to their PC. However, a design-based research methodology is used during the collaborative e-module creation process. Overall, there are three primary steps to this research: define (in the form of early investigations); design (designing an e-module); and develop (containing model testing and validation). A questionnaire and an e-module storyboard were the tools employed in this study. The storyboard is set up as a blueprint for the creation of e-modules. To make the e-module simple to comprehend, and follow by the user totally and significantly, it should be produced by the flowchart. Functionality and interaction models were criteria employed in the development of this e-module. Storyboards and flowcharts are created separately for every subject. Experts analyse the storyboard first before creating the e-module. The feasibility of the e-module is assessed using the questionnaire. One multimedia specialist and two study field experts make up the team of expert validators who conduct the feasibility test. The experts' comments about the content's quality and other elements are questions that are included in the questionnaire. Additionally, a few tests involving 20 students were carried out to find out what users thought about how simple it was to understand the idea and use the online modules designed to improve students' chemical literacy trials.

(c) Research Design

Based on the focus on the descriptive-correlational research design, this study applied a quantitative approach to inquiry. The descriptive-correlational design made it possible for the researchers to accomplish the study's objectives. Secondary teachers' writing motivation, research abilities, and perspectives on the components, scope, and importance of action research were described and evaluated using weighted mean and standard deviation. Additionally, it mainly focused on how instructors perceive the fundamental ideas and specifics of action research in the context of education. To enable statistical analysis of numbered data, the variables can be measured, often using instruments. Afterwards, design the e-module as a complement to the instructional resources that students will require to show competency after engaging in the learning process. The data from the needs analysis and the preliminary data are utilised as a guide while creating the e-module. At this point, the module's software will be chosen. After that, create the idea for the e-modules and carefully write the product design. The e-modules and quasi-experimental design are explained in the model below.

(i) Descriptive-Correlational Research Design

The descriptive correlational survey approach was used in this study's mixed-methods research design, which was then carried on to the interview stage. The descriptive correlational survey approach was chosen because it can measure the pattern of relationships between two or more variables, making it appropriate for this investigation. The benefit of survey methods is that they allow us to examine and even understand the context of the study item. After the survey results were analysed, interviews were conducted to improve the survey data's accuracy so that it could be used more reliably.

(ii) Quasi-Experimental Design

In their Matching-Only Pre-Test-Post-Test Control Group quasi-experimental research design, they used a control group only. Almost experimental planning. Matching denotes that people were not randomly assigned to groups but rather matched (on specific factors; experimental or control groups). The research design involved whole classes of higher secondary school students from several schools who take chemistry as one of their core topics. Additionally, this design is frequently chosen in studies involving education, particularly when the experimental and comparison groups make up organically assembled groups or whole classes. As a result, it was decided that a quasi-experimental research design would be appropriate for this study, particularly as it was intended to blend into naturally occurring or existing school structures without interfering with the usual school schedule. Based on the average performance of the schools in each group on the national exams, there were five clusters: one high-performing school (pass rate over 75%), two moderate-performing schools (pass rate between 50 and 74%), and two low-performing schools (pass rate below 49%). All of the kids from each of the chosen classrooms were included in the sample according to groups after the schools were divided into experimental and control groups. Five chemistry teachers from each group were also involved in the study. The selection of chemistry students in senior five was driven by the fact that they were not only enrolled in a non-exam course but also had studied chemistry for more than four years, particularly the introduction to organic chemistry in senior three; more on this in units (topics) of intervention that are scheduled for senior student's first term.

Chemistry Topics

The module's topic of chemistry is broken down into numerous major areas in the article under consideration, including fundamental chemistry, environmental chemistry, analytical chemistry, and organic chemistry. Basic chemistry, which is broken down into numerous topics such as solutions, benzene, alcohol, quantum mechanics, energy and heat, chemical equilibrium, redox, acid-base, electrochemistry, chemical bonds, and polymers, is the main area of chemistry that receives the most discussion in the modules that are studied.

(d) Data Analysis

The mean score difference and the demographic makeup of the respondents were both analysed using the usual test of descriptive statistical analysis. To determine the frequency and mean values, these data were evaluated. Because there is no safe neutral choice and a four-point Likert scale can be used to elicit specific responses, it was chosen for this study. The collected data will be evaluated to produce frequency statistics (%). The appropriateness level of the 3D Animation E-Module was explained using the minimum value and standard deviation.

(i) Pre-Test and Post-Test in Chemistry

The eminent chemistry teachers were consulted in the development of the chemistry achievement test (pre- and post-test) on the chosen chemistry topics. To assess the students' knowledge of e-modules, a pre-test comprised of 4 open-ended and 8 multiple-choice items was generated and distributed to 549 students. An immediate post-test given to both groups was used to gauge learning once the lesson was over. Intermolecular forces were the subject of six open-ended and six multiple-choice questions on the test. Examples had a useful function in revealing students' alternative conceptions. Twelve control group students who failed the post-test participated in a 15-minute semi-structured interview to discuss their post-test responses to ascertain the students' misconceptions and alternative perceptions about the subject. A team of tutors (chemistry teacher educators) and chemistry teachers from high schools assessed the test questions. With 150 students in the 12^{th} grade, the pre-test and post-test were piloted to evaluate their reliability.

5. EXPERIMENTATION AND RESULT DISCUSSION

The result of this research are presented in this section, and they are assessed using the SPSS programme. Version 22.0 of the Statistical Packages for Social Science (SPSS) was used to analyse the data. Data from the pre-test and post-test were evaluated using Student's t-test to compare students' achievement in the two groups. Statistical significance was defined as a p-value less than.05. The researchers and two knowledgeable educators also examined the open-ended questionnaire responses. Their frequency of responses was divided into three categories: the nature of the problem, the role of the teacher, and group dynamics. To analyse the teachers' responses, the data was evaluated using standard deviation and mean as statistical techniques.

Table 2: Simulation System Configuration

SPSS Statistical Tool	Version 23.0
Operation System	Windows 10 Home
Memory Capacity	6GB DDR3
Processor	Intel Core i5 @ 3.5GHz

The data from the questionnaires were analysed using the Statistical Package for the Social Sciences (SPSS) programme. For descriptive analysis, regression, and correlation analysis, a structured SPSS-based data collection was employed. In the statistical model, the link between the dependent and independent variables is estimated. As a result, the following table 2 lists the simulation tools that were employed for the suggested system. The researcher utilised a correlational treatment with an alpha of 0.05 and a confidence level of 95% to analyse the correlation between research writing competency and motivation in teachers' perceptions. The values of the range of means with descriptive interpretations that will be applied in the analysis of the data to be acquired after the survey are shown in the table above.

By their agreement with the assertions, the participants demonstrate their high appreciation for SLMs (Mean = 57.1). Nevertheless, the learners' perception of SLMs is low to moderate. This demonstrates that the students don't value reading and comprehending the discussion and examples, managing and completing the tasks and activities, or believing that the module is a reliable source of in-depth knowledge.

(a) Regression Model

An explanation of the relationship between one or more independent variables and a response, dependent, or target variable is provided by a regression model.

Table 3: Model Summary

Model Summary[b]					
Model	R	R Square	Adjusted R Square	Std. The error of the Estimate	Durbin-Watson
1	.086[a]	.007	.000	5.935	2.029
a. Predictors: (Constant), LRL, SLM, LAL, SI					
b. Dependent Variable: LO					

The model overview of the outcomes of the regression analysis is shown in table 3. The R and R^2 values are provided in this table. The "R" Column's R-value, which stands for the simple correlation, is 0.086, which denotes a strong degree of correlation. The complete variance in the dependent variable LO can be described by the independent variable, LRL, SLM, LAL, and SI, as indicated by the R^2 value (the "R Square" column). This is a very significant explanation of 0.7%.

Table 4:ANOVA Test

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	143.674	4	35.918	1.020	.397[b]
	Residual	19164.909	544	35.230		
	Total	19308.583	548			
a. Dependent Variable: LO						
b. Predictors: (Constant), LRL, SLM, LAL, SI						

The ANOVA results for the single regression model are shown in table 4, which indicates that the regression equation predicts the dependent variable and matches the data. To determine the causal relationship between one dependent variable and two independent factors, the data on learning attitude and retention were studied using an ANOVA model. Regression analysis was used to examine the data on attitudes towards chemistry to determine the association between various factors. One-way ANOVA was used in the subsequent study to determine whether there were any notable differences between the four separate groups. However, this table shows that the regression model significantly and accurately predicts the dependent variable. This demonstrates the regression model's statistical relevance. In this case, $p < 0.5$, which is higher than 0.05 and shows that the regression model statistically substantially predicts the overall outcome variable presented (i.e., it fits the data well).

Table 5: Coefficient Analysis

Coefficients[a]								
		Unstandardized Coefficients		Standardized Coefficients			95.0% Confidence Interval for B	
Model		B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound
1	(Constant)	18.118	1.496		12.114	.000	15.180	21.056
	SLM	-.041	.044	-.041	-.946	.344	-.127	.044
	SI	.028	.045	.027	.614	.540	-.061	.116
	LAL	-.031	.042	-.032	-.740	.460	-.113	.051
	LRL	.072	.043	.072	1.665	.097	-.013	.157
a. Dependent Variable: LO								

Table 5 depicts the coefficient values for the regression test, it can predict variables and assess whether they have a statistically significant impact on the model (by looking at the "Sig." column). Additionally, the constant value is 18.118, and the t value is 12.114, therefore these values in the "B" column under "Unstandardized Coefficients" can be used. However, the work's significance is 0.000, respectively.

Table 6: Residuals Statistics Results

Residuals Statistics[a]					
	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	17.45	20.99	18.61	.512	549
Residual	-10.034	16.759	.000	5.914	549
Std. Predicted Value	-2.273	4.642	.000	1.000	549
Std. Residual	-1.691	2.824	.000	.996	549
a. Dependent Variable: LO					

The residual statistics of the regression model are shown in table 6. The standard deviation is 0.512 and the mean expected values are 18.61. Standardised residuals, standard predicted value, and standard residual, respectively, have standard deviations of 5.914, 1.0, and.996. However, the average values for the residual, standard predicted value and standard residual are 0.000.

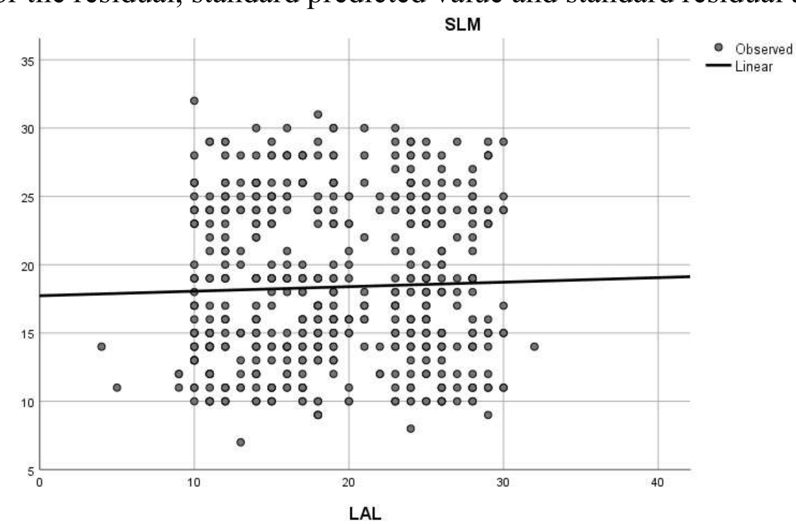

Figure 2: Scatter Plot of Regression Model

The scatter plot of the regression model is shown in figure 2. The best scores for Package design are plotted against the standardised residuals in this scatterplot. The residuals are all two standard deviations or less from the mean (0). The U-shape that is seen in the scatterplot from the conventional linear regression is replaced by a random scatter of points. The categories are optimally quantified, which enhances predictive categories.

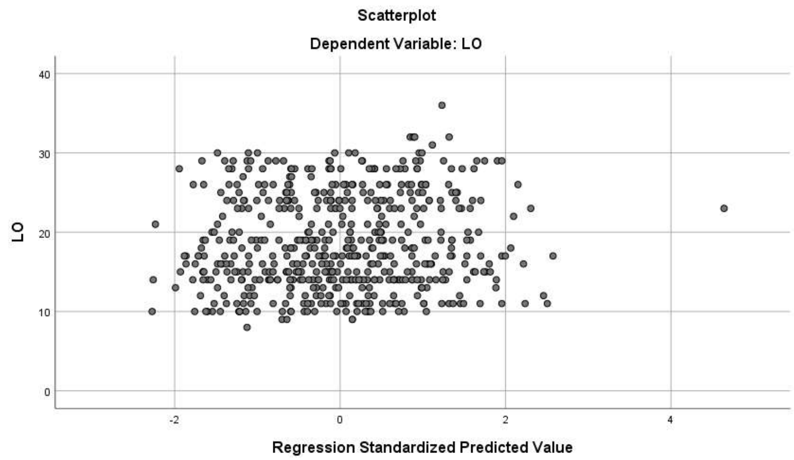

Figure 3: Regression Standardize Prediction

The regression standardise prediction model is depicted in figure 3 as an illustration of visualised residuals about the line of best fit. The residuals are shown as vertical lines. There are a lot of points close to the origin and not as many farther away. Based on the aforementioned qualities and projecting all of the residuals onto the y-axis, it is a good residual plot. This proves that the residuals of the regression model are independent and regularly distributed.

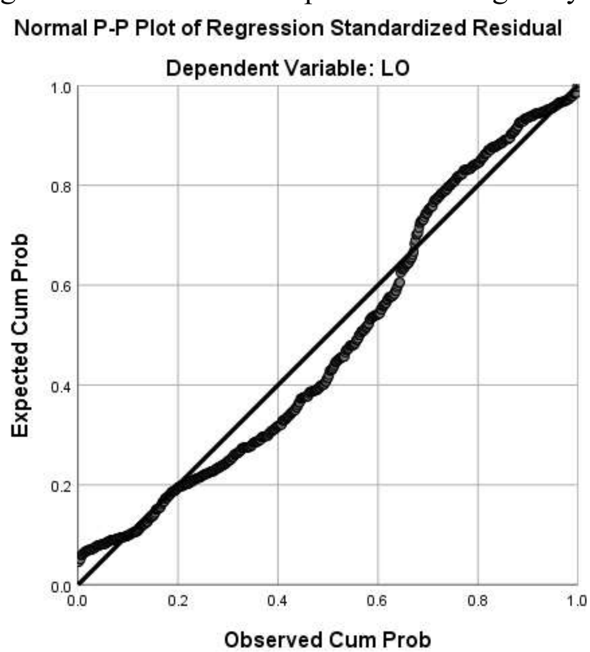

Figure 4: Normal P-P Plot of Regression

The regression model's typical P-P plot is shown in figure 4 above. The technique used to assess the regression's normality and variance homogeneity assumptions is known as a normal probability plot. The cumulative distribution function (CDF) of the standardised residual is observed and compared to the expected CDF of the normal distribution using a P-P plot. Plotting residuals associated with a normal probability graph scale against the cumulative frequency of the distribution of standardised residuals produced by the model using normal probability. Homoscedasticity is presumed to exist when the plot is a straight line devoid of curves or outliers.

The assumption of heteroscedasticity has not been met if there are curves along the line or extreme points distant from the normal probability graph scale line (outliers).

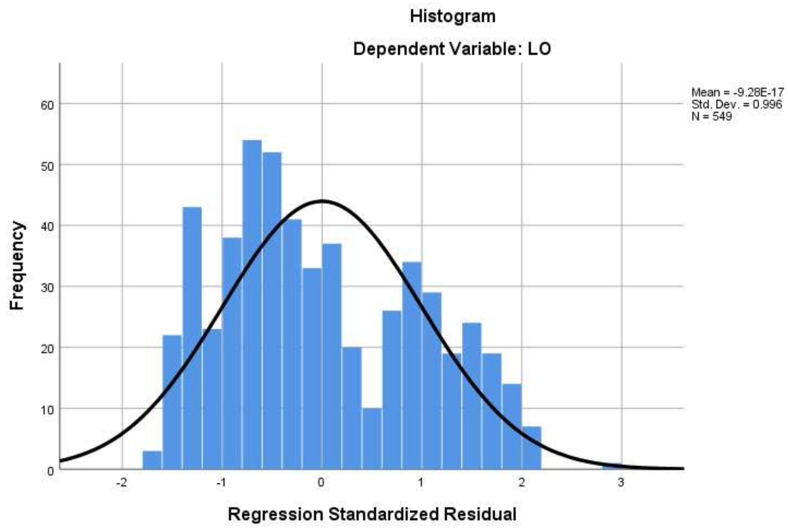

Figure 5: Regression Standardize Residuals

The regression standardise residual plot for the work provided is shown in Figure 5. The fitted values, or residual values, are shown on the x-axis and the frequency values are shown on the y-axis in residual plots. Checking the residual plots is critical after fitting a regression model. Trust the regression coefficients and other numerical results if the plots show undesirable patterns.

(b) Descriptive Statistics

A set of techniques known as descriptive statistics is used to enumerate and explain a dataset's key characteristics, such as its central tendency, variability, and distribution. In contrast to inferential statistics, descriptive statistics aims to describe the data rather than attempt to conclude the population as a whole from the sample. Here, usually describe the sample's data. This often indicates that, unlike inferential statistics, descriptive statistics are not founded on probability theory.

Table 7: Descriptive Statistics Results

Descriptive Statistics								
	N	Minimum	Maximum	Mean		Std. Deviation	Skewness	
	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Statistic	Std. Error
SLM	549	7	32	18.35	.251	5.884	.283	.104
SI	549	0	32	18.53	.246	5.757	.291	.104
LAL	549	4	32	18.88	.262	6.129	.115	.104
LRL	549	7	54	18.38	.252	5.907	.659	.104
LO	549	8	36	18.61	.253	5.936	.386	.104
Valid N (listwise)	549							

Table 7 provides an overview of the descriptive data for the self-learning module, student interest, learner attitude, learner retention, and other learning outcomes. Exceptfor passive learning activities facilitated by technology, which had the largest mean standard error of 0.262, the means of the learning activities varied slightly from the theoretical scale average. It seems that all forms of learning activities were encouraged for students in higher education courses overall. The average means for all learning outcomes showed that students believed they had gained cross-domain skills in addition to domain-specific knowledge during their higher education courses. The medium to high variances implies that pupils' perceptions varied widely among themselves.

(c) Spearman Rank Correlation Coefficient

The correlation used to evaluate the association between two ordinal variables is Spearman's rho. A positive correlation means that as one variable increases, so does the other; a negative correlation means that as one variable increases, the other declines. The sign of the correlation coefficient reflects the direction of the correlation.

Table 8: Spearman'sCorrelation Coefficient

Correlations							
			SLM	SI	LAL	LRL	LO
Spearman's rho	SLM	Correlation Coefficient	1.000	.155**	.037	-.003	.040
		Sig. (2-tailed)	.	.000	.382	.947	.346
		N	549	549	549	549	549
	SI	Correlation Coefficient	.155**	1.000	.111**	-.053	.008
		Sig. (2-tailed)	.000	.	.009	.219	.850
		N	549	549	549	549	549
	LAL	Correlation Coefficient	.037	.111**	1.000	.113**	-.026
		Sig. (2-tailed)	.382	.009	.	.008	.546
		N	549	549	549	549	549
	LRL	Correlation Coefficient	-.003	-.053	.113**	1.000	.048
		Sig. (2-tailed)	.947	.219	.008	.	.266
		N	549	549	549	549	549
	LO	Correlation Coefficient	.040	.008	-.026	.048	1.000
		Sig. (2-tailed)	.346	.850	.546	.266	.
		N	549	549	549	549	549
**. Correlation is significant at the 0.01 level (2-tailed).							

The results of the Spearman correlation coefficient are shown in Table 8. It is possible that the setup of learning modules and learning outcomes was not highly course-specific given the poor intraclass correlations for self-learning modules and learner retention level. However, the design effects calculation revealed the need to consider the variance brought on by the course level. The findings are shown in a matrix so that the replication of the relationships is seen above. However, Spearman's correlation, its significance value, and the sample size used for the calculation are all displayed in the table. For the correlations between learning module and student interest, student interest and learners' attitude, and learners' attitude and retention level, the higher Spearman's correlation coefficient, or rs, are 0.155, 0.111, and 0.113, and this is statistically significant (p =.000, .009, and.008).

(d) T-Test

The sample t-test, also known as the single sample t-test, is a statistical hypothesis test designed to ascertain whether the mean estimated from sample data obtained from a single group differs from a predetermined value set by the researcher.

Table 9: One-Sample Statistics

One-Sample Statistics				
	N	Mean	Std. Deviation	Std. Error Mean
SLM	549	18.35	5.884	.251
SI	549	18.53	5.757	.246
LAL	549	18.88	6.129	.262
LRL	549	18.38	5.907	.252
LO	549	18.61	5.936	.253

The findings of the one-sample statistics are shown in table 9 and provide descriptive statistics for the sample, including a comparison of the mean to the test value. The outcomes of the t-test are displayed in the "One-Sample Test" section. The null hypothesis in this situation is that the sample's mean values for the variables SLM, SI, LAL, LRL, and LO are 18.35, 18.53, 18.88, 18.38, and 18.61, respectively, with a lower standard error of 0.246.

Table 10: One-Sample T-Test

One-Sample Test						
	Test Value = 45					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
SLM	-106.119	548	.000	-26.647	-27.14	-26.15
SI	-107.730	548	.000	-26.470	-26.95	-25.99
LAL	-99.849	548	.000	-26.118	-26.63	-25.60
LRL	-105.577	548	.000	-26.616	-27.11	-26.12
LO	-104.169	548	.000	-26.390	-26.89	-25.89

The one-sample t-test is displayed in table 10 with the significance (alpha) level set to.05. The test's p-value is displayed in the Sig. column. The findings demonstrate that all variables' p-values (.000) are less than .05. This means that the null hypothesis can be disproved and that the sample's variables differ considerably from 18.5 in terms of significance.

6. RESEARCH CONCLUSION

Learning and teaching using modules in chemistry education is something that is commonly applied at this time. Modules present a variety of chemistry topics ranging from chemistry to high schools to universities. Chemical topics presented can be in the form of basic chemicals, organic chemistry, analytical chemistry, and environmental chemistry. The dominant material contained in the module is basic chemistry. In making modules for the teaching and learning process, one should use a pedagogical approach. The pedagogical approach used is the constructivist approach, in which students are more active in learning, not teachers. In this study, the self-learning model is presented to analyse the performance of students and their attitudes. The questionnaire data are collected from the higher secondary school students with the attitude and retention of e-modules. The use of e-modules in learning in this study was proven to increase students' retention, attitude and learning outcomes. Thus, teachers must improve their ability to master learning technology to produce teaching materials that are relevant and designed. The integration of e-modules in learning can improve the learning process and outcomes. E-modules are very useful as the main learning resource because they are designed based on the contextual characteristics of students, the uniqueness of the material and the principles of active and interactive learning and technology integration. This study analyses the quasi-experimental design for the pre-test and post-test.Frequency counts, percentages, and Spearman's rank correlation coefficient was used to analyse the data gathered with the aid of SPSS software.

The collected data from both groups were analysed by calculating the mean, standard deviation and t-test after which the results were interpreted. The results analyse that self-learning modules are effective in the retention of learning among students. Therefore, the recommendation is to apply this teaching approach in all teaching areas and subjects. The use of the e-module that has been developed, sought to establish whether there was any enhancement in students' self-learning. Although these resources can support skill transition to the clinical environment, optimal educational value for self-directed resources requires careful consideration of both the resource design and strategy for its implementation. This study determines the achievement through self-learning modules, it has a medium level of usage in e-modules for retention and attitude level, andthe self-learning modules are more effective than conventional modes. There is a positive correlation between self-learning modules and students' interests, learner's attitudes, and learning outcomes. Therefore, the use of e-modules in learning in this study was proven to increase students' interest, attitude and learning outcomes, respectively.

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