



## Effect of E-Module on the Academic Achievement of Chemistry Students at Secondary Level

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### Abstract

An experimental study was designed to find the effect of e-module on the academic achievement of chemistry students at secondary level. This study was quasi-experimental with pretest and posttest non-equivalent control group design. All female science students of 10<sup>th</sup> class of public school were the population of the study. A sample of 67 female students of 10<sup>th</sup> class was selected from a public school GGHS Sheikhpur, in the rural area. Two groups were named after the conduction of pretest as experimental group and control group. E-module was designed to teach experimental group. Module and instrument were piloted and validated through expert opinion. Data were collected through pretest and posttest. Data were analyzed through inferential statistics with the help of independent sample t-test. The findings of the study were significant as academic achievement of students of experimental group was enhanced in chemistry through teaching with e-module as compared to control group in the area of Understanding and Application. It is recommended that to minimize the use of traditional teaching methods in science subjects and to enhance the area of understanding and Application, teaching with e-module may be encouraged at the secondary level.

**Keywords:** Information and Communication Technology (ICT), Chemistry, Academic Achievement, E-module, Constructivism, Secondary Level

### 1. Introduction

The education scenario is changing with the advancement of time and there is a paradigm shift from traditional education to innovative education now it becomes the need of time because innovative education increases the efficiency and productivity of learning. There are different innovative teaching strategies used like interactive videos, simulations, virtual labs, digital modules, puzzles, and games (Serdyukov, 2017). E-learning is an efficient learning environment to transfer content on ICT devices. It is a process of learning through interactive tools like the internet, audio, and videotapes that enhance the teaching and learning process (Suresh, Priya & Gayathri, 2018).

Chemistry is an important subject of pure science that gives understanding to the students about physical and chemical changes in their surroundings. Understanding abstract concepts of chemistry is challenging for students as there is the continuous shuffling of concepts between microscopic and macroscopic levels (Sirhan, 2007).

Keeping in view the complexity of chemistry, several teaching-learning strategies are used and tested like laboratory method, project method, etc. Research has shown that the 5E learning model helps teachers to teach any concept to students in a better way. This model-oriented classroom is more motivated and active as compared to traditional classrooms. This model proves to be an important source to identify and remove the misconceptions of students regarding abstract concepts during learning (Cakir, 2017).

Instructional material is the most crucial element in the learning process and it facilitates the teaching and learning process. Successful learning requires attractive and effective pedagogical tools to enhance the understanding of learners regarding abstract concepts of science, especially chemistry. The module is an efficient example of instructional material that helps the learners to transfer their thoughts and ideas effectively by motivating their interests, thinking, their readiness to learn and also saves teachers time as they can more concentrate on the emotional, mental, and psychological development of students. The module can be in printed form or digital form (Serevina, Astra, & Sari, 2018).

Modules when used on electronic platforms are called e-modules. Learning with an e-module keeps the students active because they come in contact with interactive content (Cannarelli, Kahn, & Schneider, 2016). E-module is a systematically arranged material that is used for the teaching-learning process according to the age and level of students and teachers can use this module as a pedagogical tool to provide an efficient, independent, planned and effective way to learn and make the students able to understand the studied concepts in a better way (Linda, Nufus & Susilawati, 2020).

This e-module helps learners to enhance the learning process by concretizing abstract concepts, fostering students' interest and critical thinking that increase the academic achievement of students (Winatha & Abubakar, 2018). According to Abdullah & Mirza (2019), academic achievement gives knowledge about the educational goals that are achieved by students in a specific period. It is measured through tests and assessments usually in the form of scores. As there are different students in class with a lot of individual differences so different components of e-module are needed to tackle their differences. Moreover, the researcher is passionate about finding the cause of low results of students in chemistry. It is crucial to study the issue of less use of

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technology in local educational settings of developing countries like Pakistan to motivate the use of e-module to enhance the understanding of students regarding abstract concepts of chemistry.

### 1.1. Statement of the Problem

There is less use of technology in schools to clarify abstract concepts of science, especially chemistry. Students find chemistry a boring and difficult subject due to its abstract concepts which are not understandable deeply for the students. The reason behind this difficulty is the traditional method of teaching without the use of technology which makes chemistry an ambiguous subject with a lot of confusion in the minds of students. Teaching with e-module may help to increase the academic achievement of students so the researcher is motivated to find the effect of e-module on the academic achievement of students.

### 1.2. Objectives

Objectives of this study were to:

- i. Determine the effect of teaching with e-module on the academic achievement of chemistry students at the secondary level in the area of Understanding.
- ii. Determine the effect of teaching with e-module on the academic achievement of chemistry students at the secondary level in the area of Application.

## 2. Literature Review

Teaching and learning revolves around four pillars that are teacher, learner, teaching methodology, and learning environment. Learning becomes successful when teachers consider individual differences among students. The most important thing is the extent of interaction between teachers and students. To strengthen this interaction, teaching methods should be considered most importantly. The success rate of individuals depends on their creativity, goal setting, and way of planning and sharing their thoughts with teachers (Safdar, 2013). The teaching method is a way to carry out educational activities and to achieve specific goals during learning. There are a lot of teaching methods used for learning. These methods allow the teachers to make different and relevant arrangements for successful and effective communication. In our country, two types of thoughts are practiced in institutions. One is the traditional method and the other is ICT-based teaching.

In the traditional method, there is complete control of the teacher and discipline is strict as compared to ICT-based teaching. According to Dewey, "Traditional teaching is being imposed from above and outside". Teachers are the medium through which knowledge and behavior are being imposed on learners. The traditional teaching method is a teacher-centered approach that is most commonly used in institutions to teach science subjects.

In this modern age, only those institutions are successful that have changed their strategies, adopted technology, and modified their methods to deliver knowledge. The classroom environment has shifted from teacher-centered to learner-centered and the approach has changed from product-oriented to process-oriented. When students are involved actively in the learning and teaching process then learning becomes more effective and they cover the journey of conceptual change. Constructivist states that the most important is what students can do, perceive, and interpret as compared to what teachers can do (Tegegne, 2014).

Studies have revealed that the involvement of interactive technology in the teaching and learning process brings change in two ways. One is that it shifts instructional methods from traditional and teacher-centered to student-centered methods like laboratory simulations, games and inquiry-based teaching, etc. Secondly, it enhances the interest and curiosity among students in science subjects and they can think scientifically. Teaching becomes fruitful and brings desirable change if suitable instructional approach has been used to increase achievement of students. Inquiry approach proves to be a suitable strategy to understand difficult and abstract concepts of science and encourages the students to learn through conceptual understanding as compared to rote memorization (Jack, 2013).

Inquiry based teaching is an instructional approach used to solve problems. It demands the active participation of students in the learning process and construction of knowledge. Students are engaged in discovery of scientific process. Inquiry based instructional strategy helps to develop high-order thinking among students and enhance their practical skills through problem solving. According to constructivism, students learn according to their participation and engagement in learning process. Students are able to construct knowledge by using learning module and this type of learning mold information in their minds and enable them to modified these and construct new knowledge. Module is based on constructivism and if it is interactive and is impregnated with different activities then students are able to sprout their knowledge and learn concepts better by using their experiences within these activities (Cannarelli et al., 2016).

5E model is an instructional model to plan lesson plans of science. It is based on cognitive theory of constructivism and best used in science teaching. Different cognitive stages of learning included in this model and form learning cycle. This model focuses on clarification of the concepts of students rather than on the facts and students become active participants of teaching and learning process. This model gives clear goals to the learners, enhance scientific reasoning, develop positive attitude related to science, engage the students in learning process and remove their misconceptions. E-module gives variety of material in the form of audio,

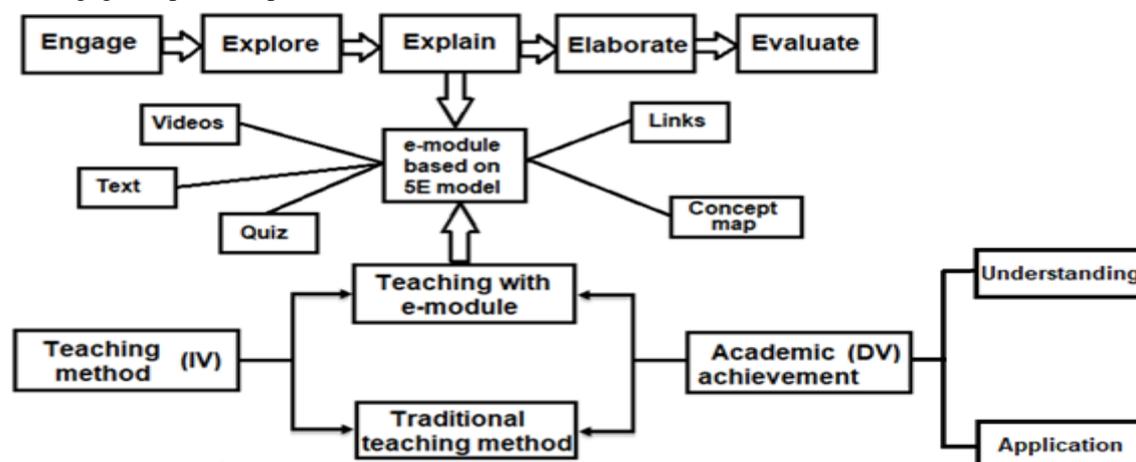
video, text, animation and simulation. Using e-module in teaching and learning process keeps learners on topic of interest (Bybee, 2015).

Secondary-level students can think abstractly to understand complex operations and think more deeply about any concept through interactive tools. Another important thing is that teachers should use a suitable approach to construct knowledge of students for successful learning (Syahroni, Dewi & Kasmui, 2016). According to research, students who are involved in practicing high order thinking skills are better to solve questions as compared to those who learn low order thinking skills. Evidences shows that both high order and low order skills are necessary for effective learning and to enhance academic achievement. Bloom's taxonomy is an important medium of communication between teacher, assessment and subject. It helps to determine the objectives of education and curriculum according to the national policy of education. It is an important source to evaluate any program, skill or course. It provides a framework to design assessment (Hassan, 2023).

Research has shown that using e-module is the best way to teach and learn in attractive manner. It is most interesting, interactive way of teaching and learning with lot of quizzes, videos, animations and simulations (Cannarelli et al., 2016). Learning with e-module is based on 5E instructional model that leads towards constructivist theory as its focus is on the construction of knowledge and embedded in the brain of learners. This model consists of 5 phases and all these starts with letter "E" that are Engage, Explore, Explain, Elaborate and Evaluate. Research has shown that e-module based on 5E model can enhance the learning outcomes of students as content presented through e-module is interesting and attractive for students with lot of interactive videos, audios and concept maps (Jogan, 2019).

### 3. Methodology

This research was Quasi experimental with pretest and posttest non-equivalent control group design. Target population for this study was all female regular science students of public secondary schools of district Gujrat. There were total 179 public schools (9904 female students) in district Gujrat who studied science subjects at secondary level. One school from rural area, GGHS Sheikhpur, was selected as sample through purposive sampling. Out of two sections, section with 34 students was assigned as experimental group and with 33 students was assigned as control group. In this study, there is one dependent variable that is academic achievement of students in the areas of Understanding and Application. Independent variable for this study is teaching method with two categories that are traditional teaching method and teaching with e-module (as pedagogical tool) in which e-module is based on 5E model with different components like concept map, text, videos, links and quiz etc. All activities in e-module were arranged according to sequence of steps in 5E model that are Engage, Explore, Explain, Elaborate and Evaluate.



**Figure.1.** Conceptual Framework of study

Pretest was developed to check the existing level of Understanding and Application of students in chemistry. Weightage of area of Understanding in test was 32% and of area of Application in test was 36%. Test was provided to six experts to ensure content validity. Content validity index was measured. Its value was 0.94 that showed test was valid. Test was revised in the light of their suggestions. Revised test was used for piloting. Reliability of test was checked with the help of test retest reliability to administer same test on same group but in two different times (with the gap of 15 days). Then scores were compared statistically to check correlation between results. Cronbach's alpha value was calculated and it was 0.98. It was shown that test is reliable to use. E-module was designed according to syllabus of class X as it may be helpful to enhance concrete understanding of students in chemistry. E-module was designed by using software MOODLE (Modular Object-Oriented Dynamic Learning Environment) that is developed by Martin Douglas at Curtin University, Australia.

Resources added on MOODLE was in the form of concept maps, text, images, videos, links and quiz according to 5E lesson plan.

E-module was designed to follow the steps of 5E model in proper sequence that are Engage, Explore, Explain, Elaborate and Evaluate.

- i. To follow first step (Engage) of 5E model, researcher was designed short videos about previous knowledge to engage the students.
- ii. In second step (Explore) of 5E model, researcher designed probing questions related to concept presented in video. This activity also enhanced the area of Understanding of students.
- iii. In third step (Explanation), researcher designed concept map and detailed text to explain topic. This activity enhanced the area of Understanding.
- iv. In fourth step (Elaborate) of 5E model, there were interactive videos about topic to enhance conceptual understanding among students. This activity enhanced the area of Understanding and Application.
- v. In last step (Evaluate) of 5E model, researcher carried evaluation to check the level of learning of students about any studied topic through MCQs and short questions to identify any difficulty in clarification of concepts. During this activity, students were able to enhance the area of Application.

#### 4. Results

Data was analyzed through inferential statistics by using SPSS software. Independent sample t test was used to compare the scores.

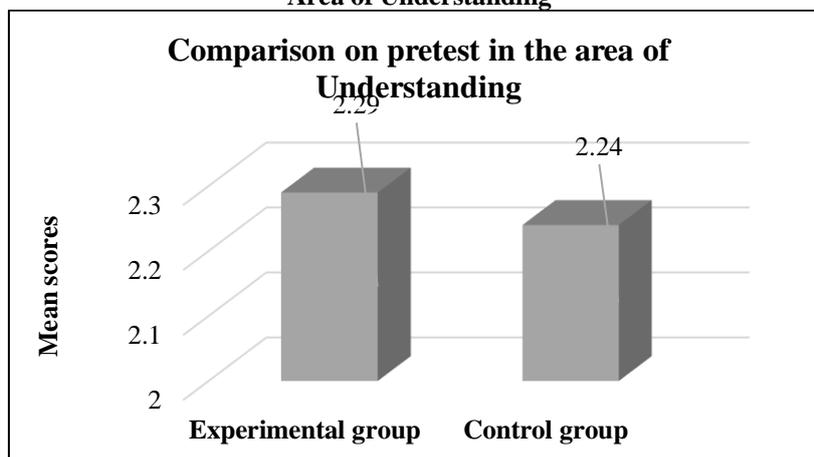
##### 4.1. Area of Understanding

**Table 1: Comparison of Experimental and Control Group Students on Pretest in the Area of Understanding**

Group	N	df	Mean	SD	t-value	p-value
Experimental	34	65	2.29	1.31	0.87	0.66
Control	33	65	2.24	1.27	0.87	0.66

Results of Table 1 showed that mean score of experimental group was 2.29 and mean score of control group was 2.24. Standard deviation of experimental group was 1.31 and of control group was 1.27. P-value was 0.66 showed that there was no significant difference between two groups regarding their performance on pretest before treatment in the area of Understanding.

**Figure 1: Comparison of Mean Scores of Experimental and Control Group Students on Pretest in the Area of Understanding**

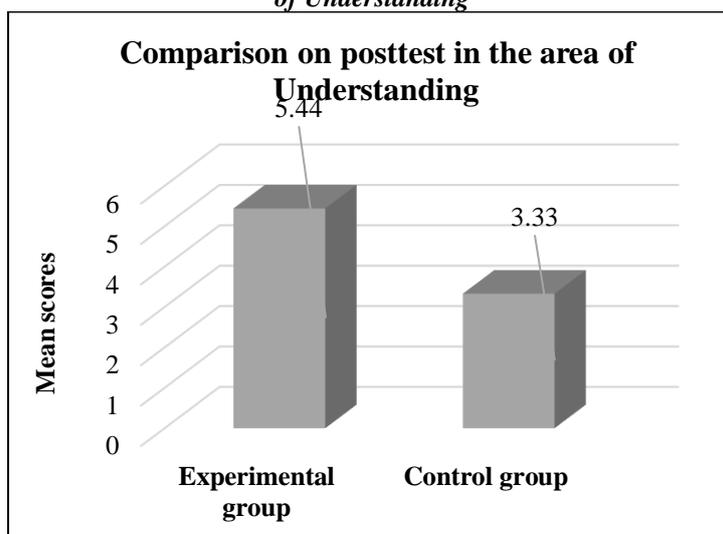


**Table 2: Comparison of Experimental and Control Group Students on Posttest in the Area of Understanding**

Group	N	df	Mean	SD	t-value	p-value
Experimental	34	65	5.44	1.10	0.00	0.004
Control	33	65	3.33	1.63	0.00	0.004

Results of Table 2 showed that mean score of experimental group was 5.44 and mean score of control group was 3.33. Standard deviation of experimental group was 1.10 and of control group was 1.63. P-value was 0.004 indicated that there was significant difference between two groups regarding their performance on posttest after treatment in area of Understanding.

**Figure 2: Comparison of Mean Scores of Experimental and Control Group Students on Posttest in the Area of Understanding**



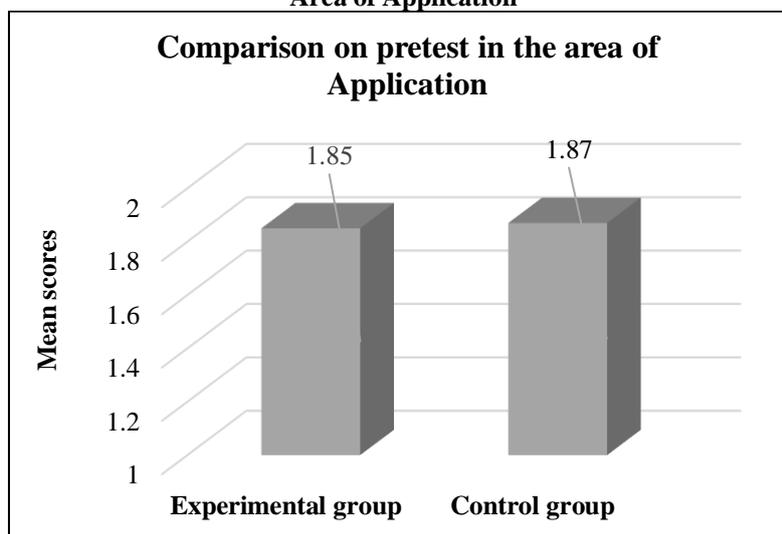
#### 4.2. Area of Application

**Table 3: Comparison of experimental and control group students on pretest in the area of Application**

Group	N	df	Mean	SD	t-value	p-value
Experimental	34	65	1.85	1.18	0.93	0.98
Control	33	65	1.87	1.24	0.93	0.98

Results of Table 3 showed the mean score of experimental group was 1.85 and mean score of control group was 1.87. Standard deviation of experimental group was 1.18 and of control group was 1.24. P-value was 0.98 showed that there was no significant difference between two groups regarding their performance on pretest before treatment in area of Application.

**Figure 3: Comparison of Mean Scores of Experimental and Control Group Students on Pretest in the Area of Application**

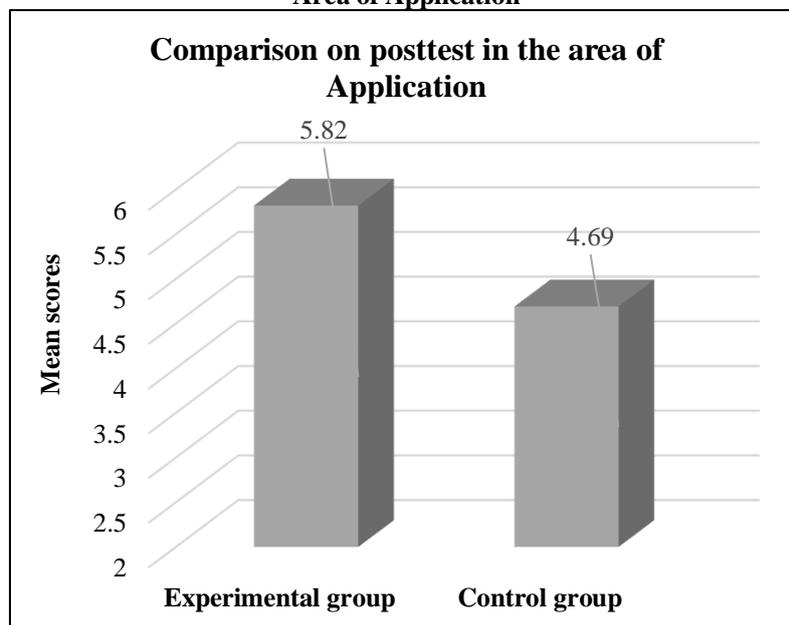


**Table 4: Comparison of Experimental and Control Group Students on Posttest in the Area of Application**

Group	N	df	Mean	SD	t-value	p-value
Experimental	34	65	5.82	1.16	0.00	0.03
Control	33	65	4.69	1.28	0.00	0.03

Results of Table 4 showed the mean score of experimental group was 5.82 and mean score of control group was 4.69. Standard deviation of experimental group was 1.16 and of control group was 1.28. P-value was 0.03 showed there was significant difference between two groups regarding their performance on posttest after treatment in area of Application.

**Figure 4: Comparison of Mean Scores of Experimental and Control Group Students on Posttest in the Area of Application**



## 5. Findings and Discussion

Results of this study showed that e-module proved to be effective in enhancing the academic achievement of students in chemistry at secondary level, the same has been pointed out by Kuit & Osman (2021). Due to the abstract nature of chemistry, it is difficult for students to clarify these concepts with the help of traditional methods. E-module enhanced the Understanding and Application level of students. It was also stressed by Yuliani, Wiji & Mulyani (2021, March) that the majority of electronic modules can improve the concepts and learning outcomes of students. The current study showed that Understanding and Application level of students were enhanced through the use of e-module based on 5E model and in turn academic achievement was high in the case of the experimental group. The findings of this study are also in line with Winatha & Abubakar (2018), who concluded that the academic achievement of students by using interactive e-module.

## 6. Conclusion and Recommendation

The study concluded that the performance of students of the experimental and control groups was almost same before intervention in the areas of Understanding and Application but after using e-module, experimental group showed better results as compared to control group in areas of Understanding and Application. It concluded that teaching with e-module has effect on academic achievement of students in chemistry in the areas of Understanding and Application. Reason behind the difficulty in chemistry is the traditional method of teaching. Conceptual understanding of students of experimental group regarding different abstract concepts of chemistry and application of these concepts was better after teaching with interactive e-module.

Despite some limitations in the study, this study has effectively contributed to the literature regarding the effect of e-module to enhance the academic achievement of students.

The researcher has not covered all aspects of study so it is recommended that other researchers may study the effect of e-module on other variables like motivation, interest and self-learning etc. Moreover, this can be conducted on other levels with different populations.

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