

Effectiveness of Instructional Strategy based on Kolb's Experiential Learning Model on Conceptual Understanding of the Students

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ABSTRACT

The present experimental study investigates the effectiveness of an instructional strategy based on Kolb's Experiential Learning Model in improving students conceptual understanding in science education. A two-group pretest-post-test design was employed, wherein students were divided into two groups: the experimental group received instruction structured around Kolb's four-stage learning cycle , which are Concrete Experience, Reflective Observation, Abstract Conceptualization, and Active Experimentation, while the control group was taught using conventional methods. To assess learning outcomes and student engagement, data were collected using stage- specific rubrics, a situational test focusing on applied understanding, and a student reaction scale. The data were analysed using mean scores and percentage distributions for each stage of the learning model. The results revealed that students in the experimental group achieved the Accomplished level across all stages, as defined by the evaluative criteria developed by the researcher. In comparison to the control group, the experimental group showed a significant improvement in conceptual understanding and engagement. These findings underscore the pedagogical value of experiential learning strategies in enhancing science education, particularly by promoting active participation and deeper conceptual clarity among learners.

INTRODUCTION

In today's changing educational landscape, the focus has moved away from rote learning and passive knowledge absorption toward active, engaging learning experiences that promote deeper analysis and comprehension. Traditional teaching methods, primarily characterized by teacher-centred lectures, are often criticized for restricting student participation and limiting the development of critical thinking skills. In contrast, learner-centred instructional approaches, are gaining momentum for their ability to actively involve students in the learning process and

improve conceptual clarity. An important model supporting this shift is Kolb's Experiential Learning Model (KELM), which views learning as a cyclical process comprising four stages: concrete experience, reflective observation, abstract conceptualization, and active experimentation. Kolb (1984) suggests that meaningful learning happens when learners relate their experiences to academic concepts and apply this understanding in practical contexts. This model supports not only analytical and problem-solving skills but also accommodates individual learning styles, leading to deeper understanding. Achieving conceptual understanding, which involves the meaningful integration and application of knowledge rather than just memorization, has become a key goal in modern education. NEP 2020 also emphasizes that learning for children should be holistic, enjoyable, and engaging, moving beyond rote memorization. It promotes experiential learning through hands-on activities, inquiry-based methods, and real-life experiences. The policy aims to foster critical thinking, creativity, and conceptual understanding from an early age. To attain this, instructional methods must actively engage learners in learning process, and the construction of knowledge. Kolb's model offers a strong foundation for such strategies by encouraging learning through experience and reflection. This study, therefore, aims to investigate how an instructional approach based on Kolb's Experiential Learning Model influences students conceptual understanding in science subject.

Teaching and Learning

Teaching and learning are deeply interconnected, with psychological theories playing a vital role in shaping our understanding of learning. Early behaviourist thinkers like Watson, Thorndike, and Skinner emphasized learning as a response to environmental stimuli, giving rise to the stimulus-response (S-R) model that dominated mid-20th-century psychology. This view significantly influenced education, leading to structured, programmed learning models developed by scholars such as Skinner and Crowder. However, this mechanistic approach was later challenged by Gestalt psychologists and constructivist theorists like Kohler, Wertheimer, and Piaget. They argued for a more holistic, cognitive understanding of learning that considers mental processes and individual meaning-making. This shift was supported by contributions from Bruner and Gagne, who emphasized the active role of the learner. Today, constructivism is widely accepted in education, offering a learner-centred, meaningful approach that encourages active participation and deeper understanding, making it a preferred framework for designing effective instructional strategies.

Meaning and Nature of Science Education

Science education refers to the teaching and learning of science concepts, principles, and processes across different levels of education. It aims to develop learners understanding of the natural and physical world through observation, experimentation, and logical reasoning. Science

education is not limited to the acquisition of facts but also involves developing skills such as inquiry, critical thinking, and problem-solving, along with fostering scientific attitudes like curiosity, objectivity, and open-mindedness (National Research Council, 1996). The nature of science education is both theoretical and practical. It emphasizes the process of scientific inquiry. This inquiry-based approach helps students understand that scientific knowledge is tentative, empirical, and theory-laden (Lederman, 2007). Science education when instructed in scientific approach promotes conceptual understanding rather than rote memorization. It encourages learners to construct their own understanding of scientific phenomena through active engagement and reflection (Driver, Asoko, Leach, Mortimer, & Scott, 1994). Thus, science education plays a vital role in both personal development and societal advancement. (Bybee, 1997)

Experiential Learning

Experiential learning is a dynamic and transformative scientific approach that emphasizes the development of knowledge, skills, and values through direct experiences rather than traditional academic instruction. Rooted in the work of David Kolb (1984), this method posits that individuals learn most effectively when they are actively engaged in a process of meaning-making that involves personal involvement and reflection. Unlike passive learning, which relies on rote memorization, experiential learning immerses learners in hands-on activities, real-life problem-solving, experimentation, and reflective practices. This approach not only bridges the gap between theory and practice but also fosters critical thinking, creativity, and a commitment to lifelong learning. Key characteristics of experiential learning include its learner-centred nature, where individuals take an active role in their learning process; its reflective component, which encourages learners to think deeply about their experiences; its contextual relevance, connecting learning to authentic, real-life situations; its active and dynamic nature, promoting learning through doing and experimenting; and its integrative quality, which combines emotional, cognitive, and physical aspects of learning (Kolb, 1984; Beard & Wilson, 2018).

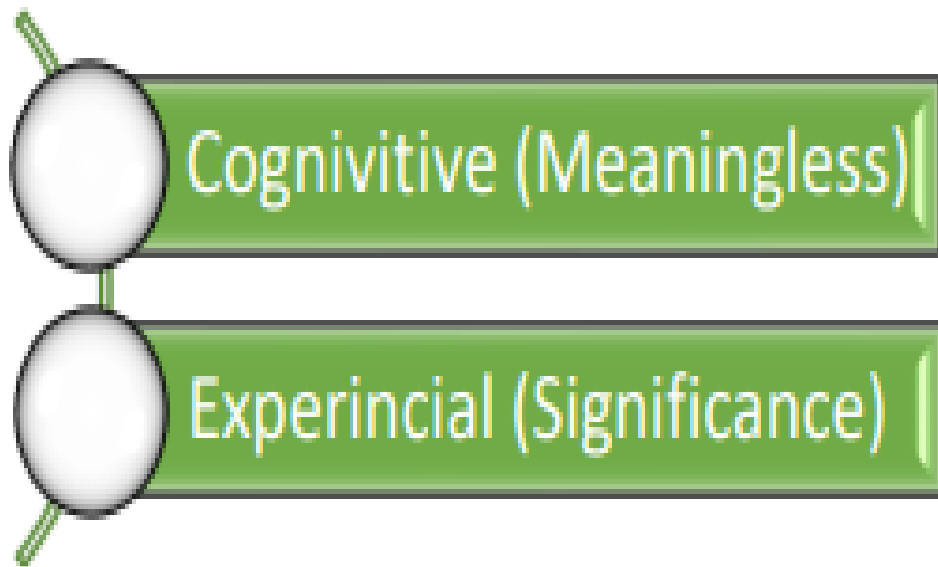
Theories on Experiential Learning

Carl Rogers's Experiential Learning Theory

Carl Rogers's Experiential Learning Theory highlights the role of personal involvement and self-directed learning in education. He argued that meaningful learning happens when learners are emotionally and cognitively engaged with content that connects to their own experiences and goals. Unlike mere factual learning, experiential learning leads to deeper personal growth and lasting change. Rogers emphasized the teacher's role as a facilitator, promoting a supportive environment that encourages exploration, reflection, and autonomy. His humanistic approach

places the learner at the centre of the educational process, fostering intrinsic motivation and self-evaluation. Rogers distinguished two types of learning in which he argued that Cognitive Learning is meaningless whereas experiential learning is meaningful and significance.

Figure 1. Types of learning according to Carl Rogers



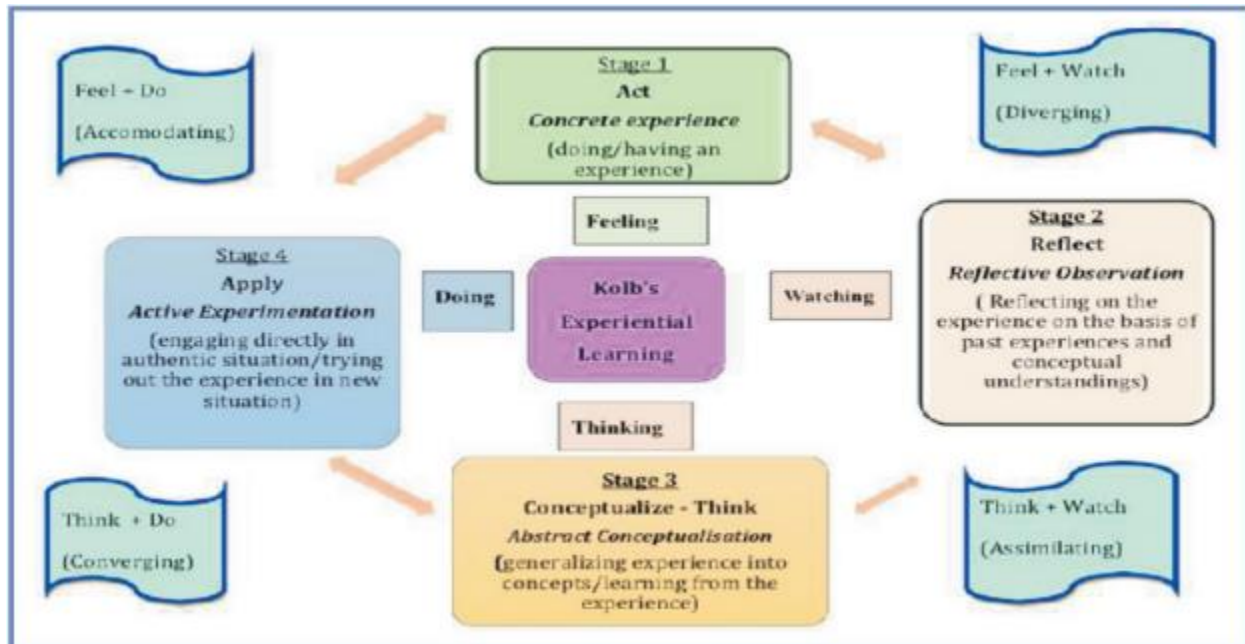
John Deweys views on Experiential Learning

John Dewey viewed experiential learning as a foundational aspect of meaningful education, emphasizing that learning occurs best through active participation and reflection on real-life experiences. He believed that education should connect to the learner's environment and interests, fostering problem-solving and critical thinking skills (Dewey, 1938). Dewey argued that experience alone is not enough; it must be purposefully structured to lead to growth. He promoted a democratic classroom where teachers guide rather than dictate learning. His approach laid the groundwork for progressive, learner-centred education.

David Kolb's Experiential Learning Model

Kolb's Experiential Learning Model is a widely accepted framework that explains how individuals learn through a cyclical process involving experience, reflection, conceptualization, and experimentation.

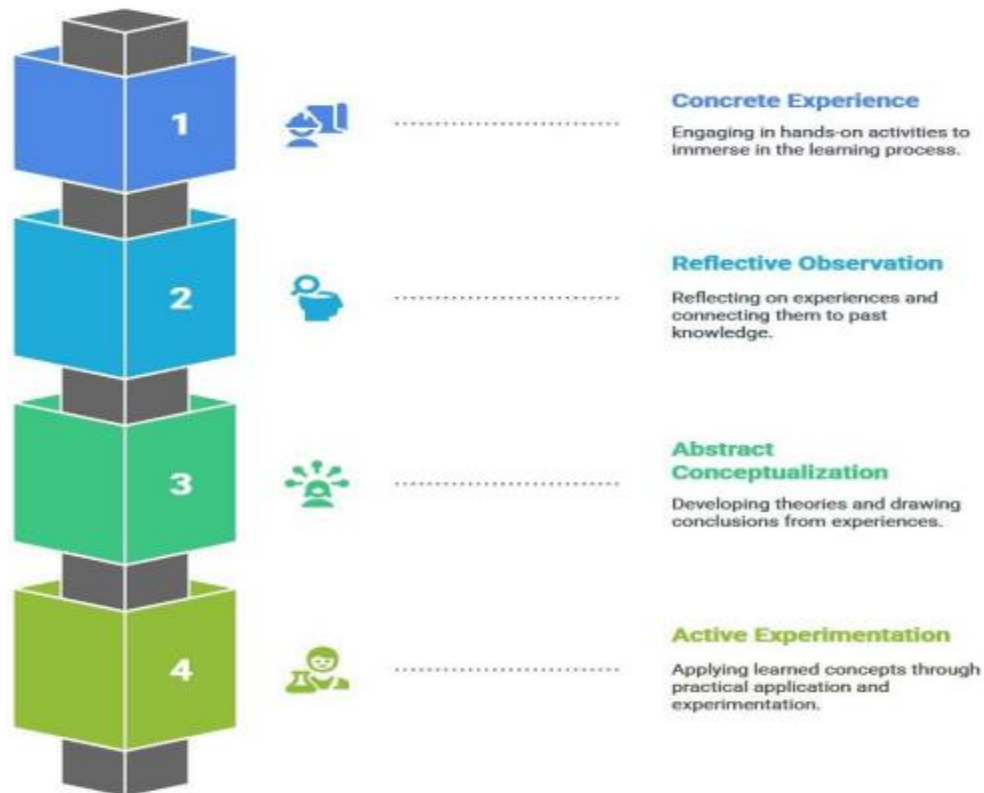
Figure 2. Kolb’s Experiential Learning Model



(Adapted from The Secretary, Central Board of Secondary Education)

According to Kolb (1984), effective learning occurs when a learner progresses through four stages i.e., Concrete Experience (CE) where they engage in a new experience; Reflective Observation (RO) where they reflect on that experience; Abstract Conceptualization (AC) where they form theories or concepts based on their reflections; Active Experimentation (AE) where they apply their new ideas in real-world situations. This model emphasizes that learning is a continuous, dynamic process influenced by both personal experiences and cognitive processing. Kolb also identified four learning style namely: Diverging, Assimilating, Converging, Accommodating. These learning styles are based on how individuals prefer to learn. The model provides a practical foundation for designing learner-centred instructional strategies that promote deeper understanding through active engagement. Kolb’s Experiential Learning Model is defined by six key characteristics that emphasize the dynamic and interactive nature of learning. Firstly, learning is viewed not as a static outcome but as an ongoing, evolving process. It is rooted in direct experience and unfolds continuously through active engagement. Furthermore, learning is seen as a holistic activity that encompasses the whole person, emotionally, cognitively, and physically, as they adapt to their environment. It also involves constant interaction between the learner and their surroundings. Ultimately, learning is understood as the creation of knowledge through the integration of shared social understanding and personal experiences. Kolb has given four stages of experiential learning which is illustrated in Figure 3.

Figure 3. Stages of Kolb’s Experiential Learning Model



Stages of Kolb’s Experiential Learning Model

Experiential Learning Approach in Science Education

Science is a dynamic and evolving discipline that relies on processes such as observation, experimentation, and hypothesis testing, rather than rigid steps (NCERT, 2005). The scientific method is interactive and flexible, often influenced by the interplay between theory and experimentation. In the context of education, science emerged as a distinct research field about four decades ago, developing methodologies suited to its unique challenges (Driver, Guesne, & Tiberghien, 1985). Research has shown that teaching and learning science are complex, context-specific, and best understood through experiential, activity-based methods (Hodson, 1996). This approach gained prominence during the evaluation of inquiry-based curricula in the 1960s and 70s across several countries (Bybee, 1997). Particularly at the upper primary level, students should be introduced to science through relatable concepts, hands-on experiences, and group investigations (NCERT, 2005). Emphasizing process skills and meaningful inquiry helps students develop the ability to learn independently, an essential aim of experiential learning in science education (Kolb, 1984).

Rationale of the Study

Science as a subject requires attention to both the process and product of learning. Kolb's Experiential Learning Model (KELM) supports this dual focus by promoting a cycle of learning that includes concrete experience, reflective observation, abstract conceptualization, and active experimentation. Aligned with the National Education Policy (NEP) 2020, this approach encourages the development of critical and creative thinking, problem-solving, and, most importantly, the ability to learn "how to learn". NEP 2020 advocates for a shift from rote memorization to experiential and inquiry-driven learning that is multidisciplinary, engaging, and learner-centred. It emphasizes nurturing the holistic potential of each learner, not only their cognitive skills but also their emotional and ethical capacities through real-life, hands-on learning experiences. The policy also recognizes the growing demand for a skilled workforce and calls for innovative pedagogies and well-equipped teachers. In this context, the present study explores how an instructional strategy based on Kolb's model can address current gaps in science education by emphasizing reflective and process-oriented learning that empowers students at every stage.

OBJECTIVES

1. To develop Instructional Strategy based on Kolb's Experiential Learning Model to teach science at class 8th.
2. To measure effectiveness of developed Instructional Strategy based on Kolb's Experiential Learning Model to teach science at class 8th in terms of Conceptual Understanding of the students.
3. To find out opinion of students on using Instructional Strategy based on Kolb's Experiential Learning model to teach science at class 8th.

HYPOTHESES:

H1: There will be a significant difference between mean gain score of control and experimental group on conceptual understanding of students studying in std 8th in science subject.

VARIABLES OF THE STUDY:

1. **Independent Variable:** The present study will measure the effectiveness of Kolb's experiential learning model. Therefore, instructional strategy based on Kolb's Experiential Learning model is independent variable.
2. **Dependent Variable:** The present study measures the application skill .Therefore,

Conceptual understanding is dependent variable.

3. **Controlled Variable:** In the present study Medium of instruction (English Medium), std 8th and science subject are control variables.

OPERATIONAL DEFINITIONS

Effectiveness: In present study, Effectiveness means enhancement in the stage of conceptual understanding of the students after being intervened by the instructional strategy based on Kolb's experiential learning model.

Conceptual understanding: In the present study, Conceptual understanding means the ability to transfer their knowledge into real situations and apply it to new contexts in the situational questions given to the students. The response given by the respondents on the situational questions given to the students.

Instructional Strategy: In the present study, Instructional Strategy means the teaching learning process designed by the researcher based on the four stages given by Kolb's Experiential Learning Model which consisted of activities based on Sound Chapter of standard 8th NCERT curriculum.

DELIMITATION OF THE STUDY

1. The present study will be delimited to English Medium schools following the syllabus of science prescribed by NCERT.
2. This study will be delimited to the students of English medium schools of standard 8th of Gandhinagar city.

RESEARCH DESIGN

The study is experimental study in nature. The Quasi-experimental method was used by the researcher. Two Group pre-test post-test design (Best and Kahn;2004) was used in conducting present study.

POPULATION AND SAMPLE

The population for the present study comprised of all the students of 8th standard studying in English Medium Upper Primary School of Gandhinagar city following the syllabus prescribed by NCERT.

The sample of the study was selected randomly by simple random sampling. In the present study

there was total 14 students. (07 students were in the controlled group whereas 07 students were in the experimental group.)

Table 1. Sample of the study

In the present study the school was selected by purposive sampling technique by the researcher and the following criteria were considered.

- a) School teaching from the NCERT textbook
- b) School having Std 8th
- c) School having English medium as the medium of instruction.
- d) Permission granted to conduct the intervention

Standard	School	Number of students
8th English Medium	Ved Integrated School, Gandhinagar	07 (Experimental Group)
8th English Medium	Ved Integrated School, Gandhinagar	07 (Controlled Group)

DEVELOPMENT OF INSTRUCTIONAL STRATEGY

The five days program was developed by the researcher based on the four stages of Kolb’s Experiential Model. In each activity a child passes through all these 4 stages an ultimately leads to the active experimentation stage. Thus, the activities included in the program were designed in such a way but it involved the learner in the learning which directly leads to experiential learning. At the end of the daily program the assignment was being given to the students. This entire program was evaluated on the daily basis by continuously observing the students. The instructional strategy was designed using Kolb’s Experiential Learning Model, which includes four stages: Concrete Experience, Reflective Observation, Abstract Conceptualization, and Active Experimentation. In Concrete Experience, learners engage in real-world tasks using their senses, while teachers act as facilitators and motivators, ensuring a supportive environment. In Reflective Observation, students reflect on experiences, often through journaling or discussions, and teachers guide this process by asking probing questions. In Abstract Conceptualization, learners form theories from reflections, and teachers support by connecting these insights to relevant concepts. In Active Experimentation, students apply their learning

through practical tasks, while teachers provide feedback and enable risk-taking. The program ensures every activity moves through all four stages, making learning experiential and student-driven. Teachers play a key role as facilitators, guiding reflection, encouraging experimentation, and monitoring growth. Students collaborate, reflect, and apply ideas, forming a personalized learning path.

Collections of Items: The items in the situational test were constructed taking into consideration the five days program developed by the researcher . The items were collected from the online source and designed by the researcher with reference to NCERT textbook of std 8th. Majority of the items of the test were designed by the researcher.

Research Tools

The three tools were developed by the researcher. The tools were;

- a) **Rubrics-** The Rubrics was developed by the researcher that consisted of 22 items based on the components of the Kolb's Experiential Learning Model. The tool was prepared taking into consideration the instructional strategy for 5 days.
- b) **Situational Test -** The situational test developed by the researcher consisted of 13 items.
- c) **Students Reaction Scale:** The students reaction scale was for reflection of students on the instructional strategy used by the researcher in the teaching learning process of Sound chapter of science. The researcher developed 15 statements for students' reaction scale that consists of both positives and negative statements.

All the three tools were validated taking the expert opinion, the experts were taken from education and science background.

DATA COLLECTION

The researcher conducted the study at Ved Integrated School, Gandhinagar, with prior permission from the principal and management. Tools such as the Situational Test, Rubrics, and Student Reaction Scale were self-administered. The instructional program was implemented by the researcher, who regularly assessed students using rubrics. The same Situational Test was used for both pre- and post-assessment. The Student Reaction Scale was given post-intervention to gauge student responses.

DATA ANALYSIS

The data in the qualitative form converted to scores by the researcher. The Rubrics was analysed

by classifying the data into the 4 stages i.e., Beginning Stage, Developing Stage, Accomplished Stage and Proficient Stage. All these stages are analysed by the descriptors by allotting various parameters to each of them. The pointers are given to all the stages i.e., 1,2,3 and 4 respectively for further analysis and to draw out the conclusion. The situational test also contains 4 parameters on basis of which the test is analysed. Thus, in both the cases the data is in the descriptive form that leads to the Qualitative data further classified to scores. The student’s reaction Scale consists of the 3 pointers that is analysed by the chi square.

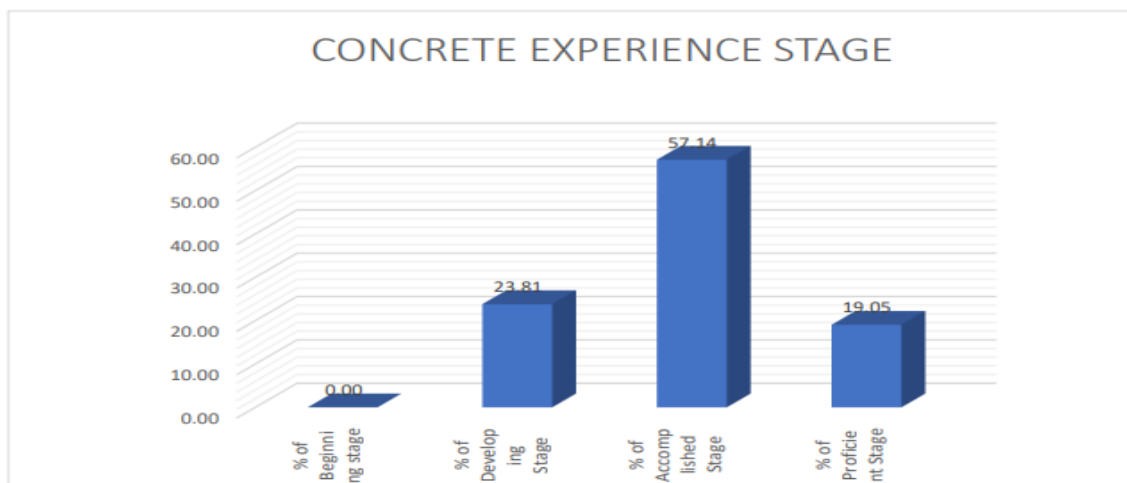
Table 2. Objective wise distribution of tools and data analysis technique for the study

Objectives	Source of Data	Tools used	Data Analysis Technique
2 nd	Researcher	Rubrics	Percentage
	Students	Situational Test	Mean and U test
3 rd	Students	Students Reaction Scale	Chi square

RESULT AND DISCUSSION

A) Findings of Objective 2nd

Figure 3. Rubrics Analysis of Concrete Experience stage



The figure 3 shows the data of number of students attained the particular stage of Kolb’s

Experiential Learning Model at Concrete Experience Stage. It can be Observed from the graph that maximum i.e. 57.14% of students have attained Accomplished Stage , while no one is at the Beginning Stage . 23.81% of students are at the Developing stage and 19.05% of students are at the Proficient Stage of Concrete Experience. Thus it can interpret that the instructional strategy based on Kolb’s Model is effective in developing the Concrete Experience Skill of the students.

Figure 4. Component wise analysis of Rubrics of Concrete Experience Stage

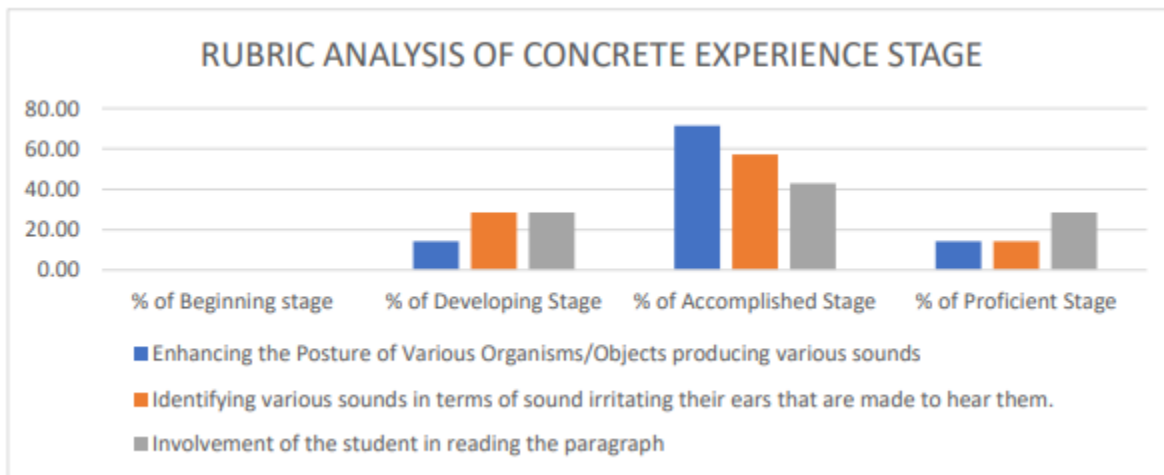
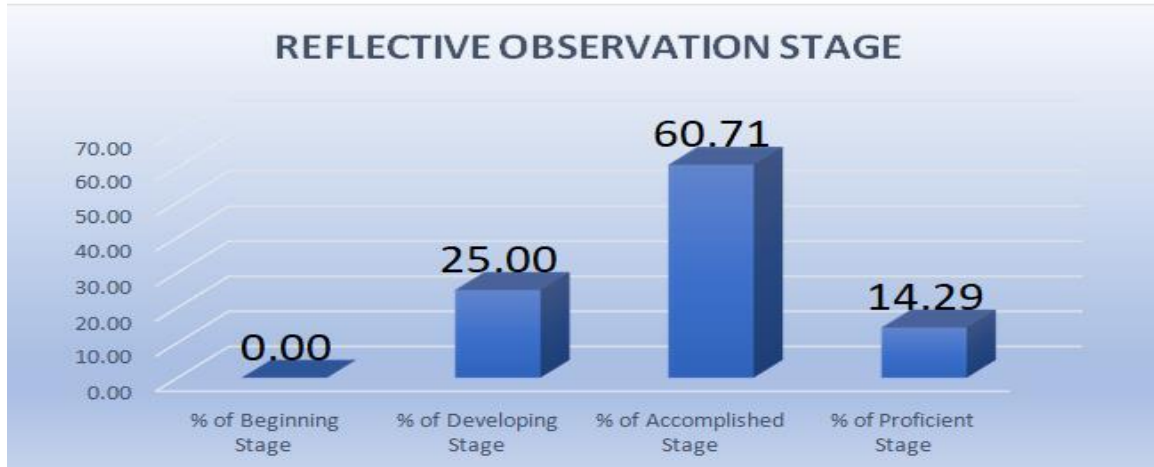


Figure 5. Students in Concrete Experience Stage



Figure 6. Rubrics Analysis of Reflective Observation Stage



The graph shows the data of number of students attained the particular stage of Kolb’s Experiential Learning Model at Reflective Observation Stage. It can be Observed from the figure 6 that maximum 60.71% of students have attained Accomplished Stage , while no one is at the Beginning Stage . 25% of students are at the Developing stage and 14.29% of students are at the Proficient Stage of Reflective Observation. Thus it can interpret that the instructional strategy based on Kolb’s Model is effective in developing the Reflective Observation Skill of the students.

Figure 7. Component wise analyses of rubrics of Reflective observation stage

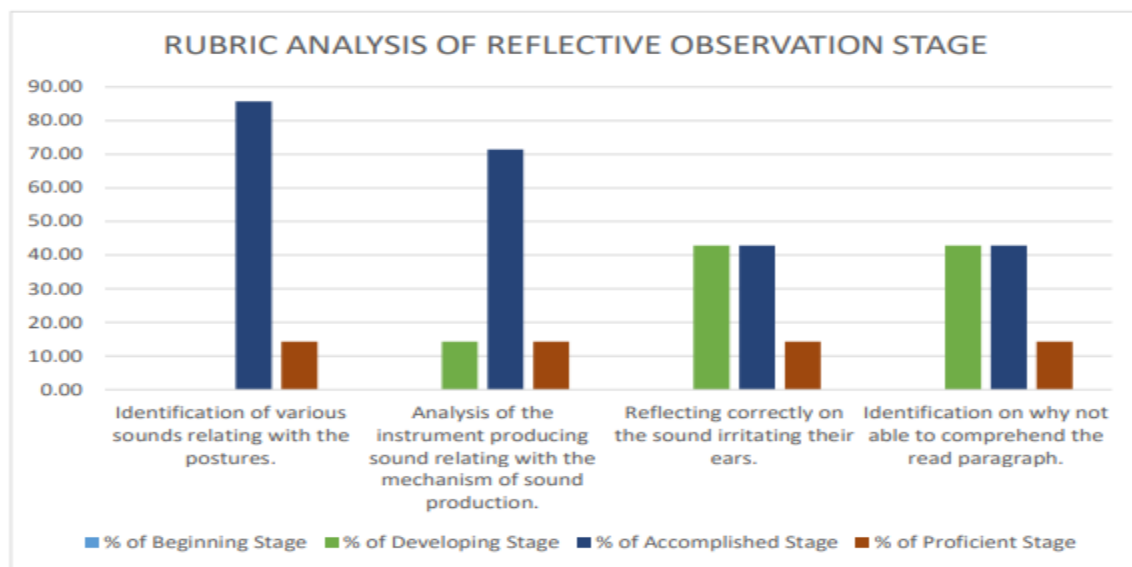
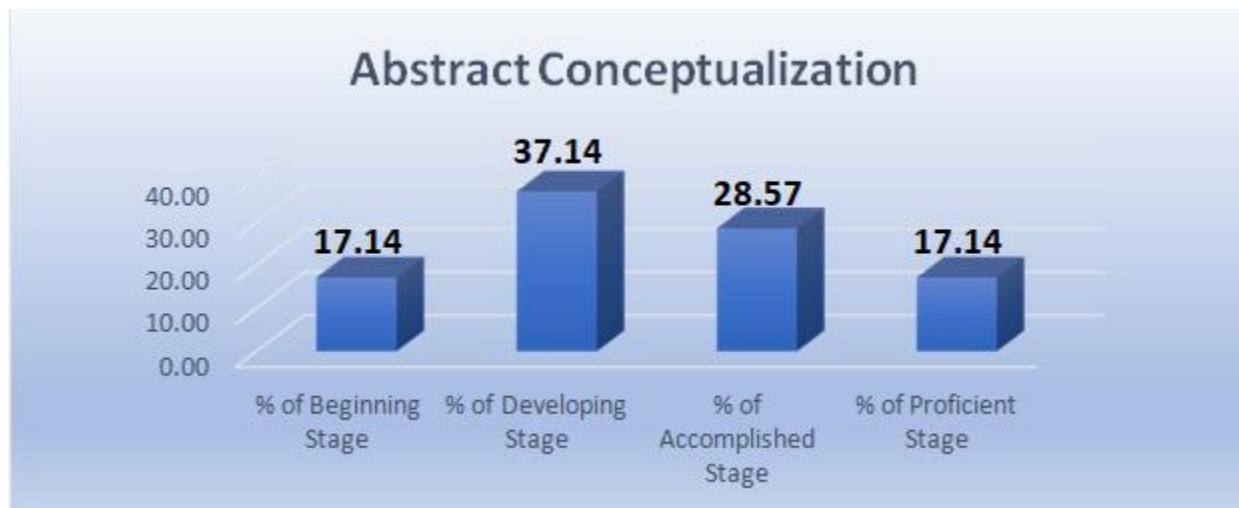


Figure 8. Students in Reflective Observation stage



Figure 9. Rubric analysis of abstract conceptualization stage



The figure 9 shows the data of number of students attained the particular stage of Kolb's Experiential Learning Model at Abstract Conceptualization Stage. It can be Observed from the graph that maximum 37.14% of students have attained Developing stage , while 17.14% students are at the Beginning Stage . 28.57% of students are at the Accomplished stage and 17.14% of students are at the Proficient Stage of Abstract Conceptualization. Thus it can interpret that the instructional strategy based on Kolb's Model is effective in developing stage of the Abstract Conceptualization level of Kolb's Model.

Figure 10. Component wise analyses of rubrics of Abstract Conceptualization stage

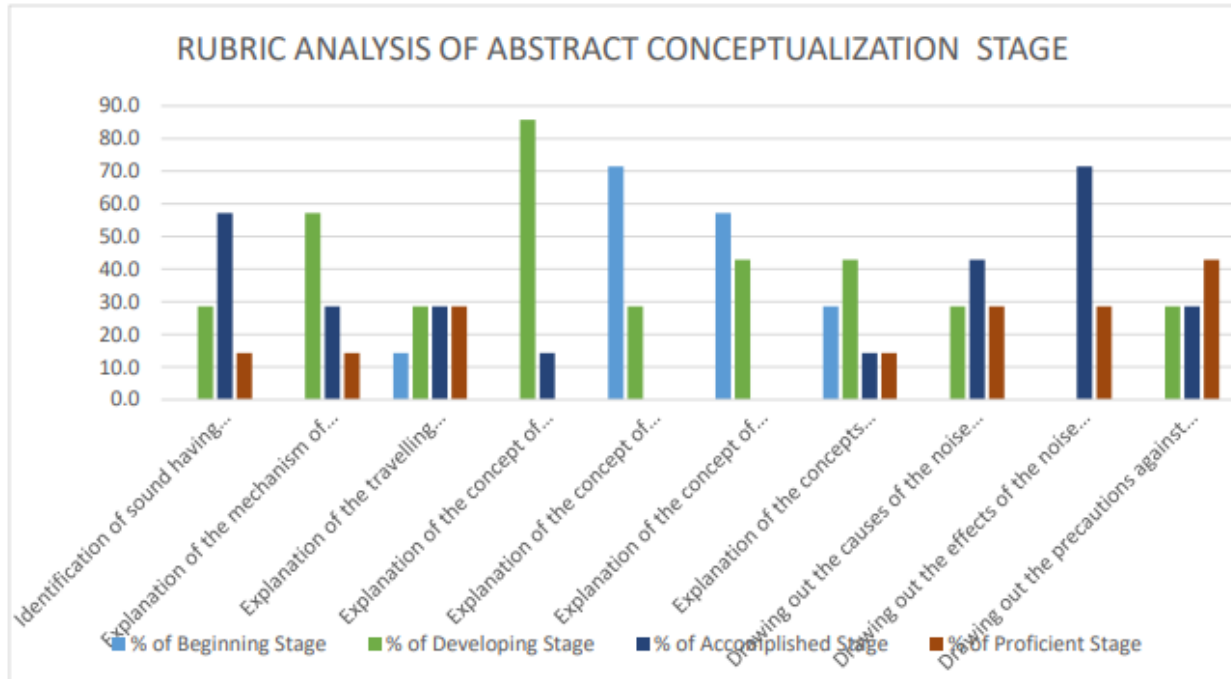
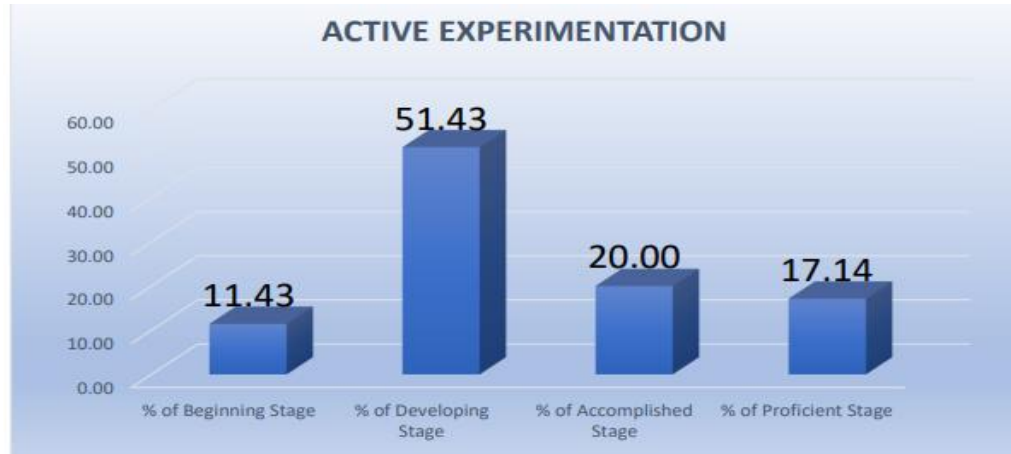


Figure-11. Students in Abstract Conceptualization stage

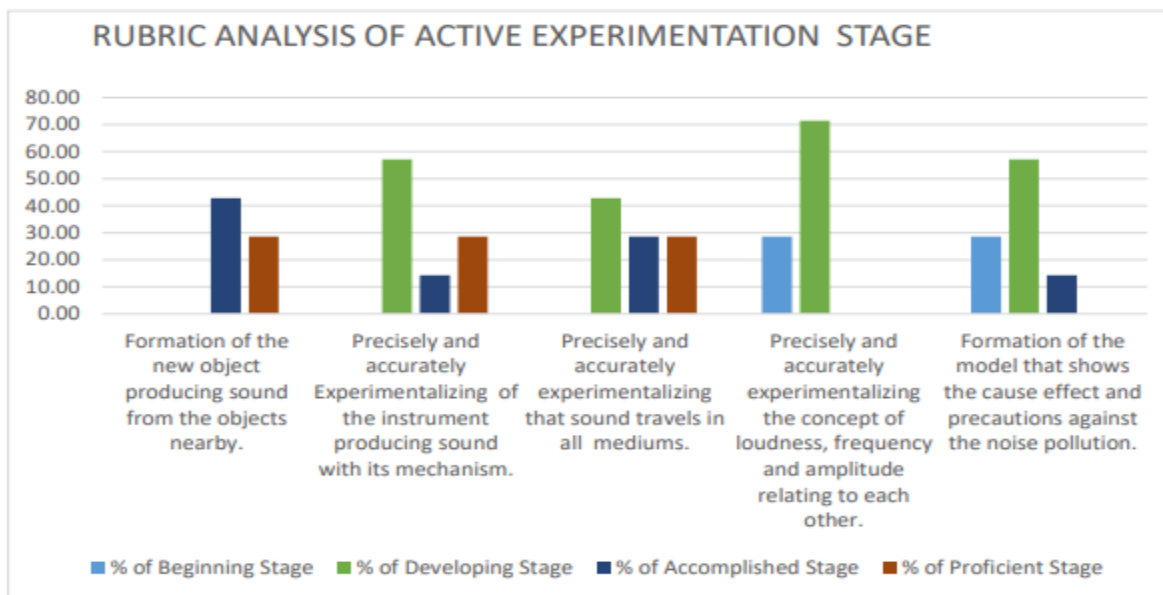


Figure 12. Rubrics Analysis of Active Experiment



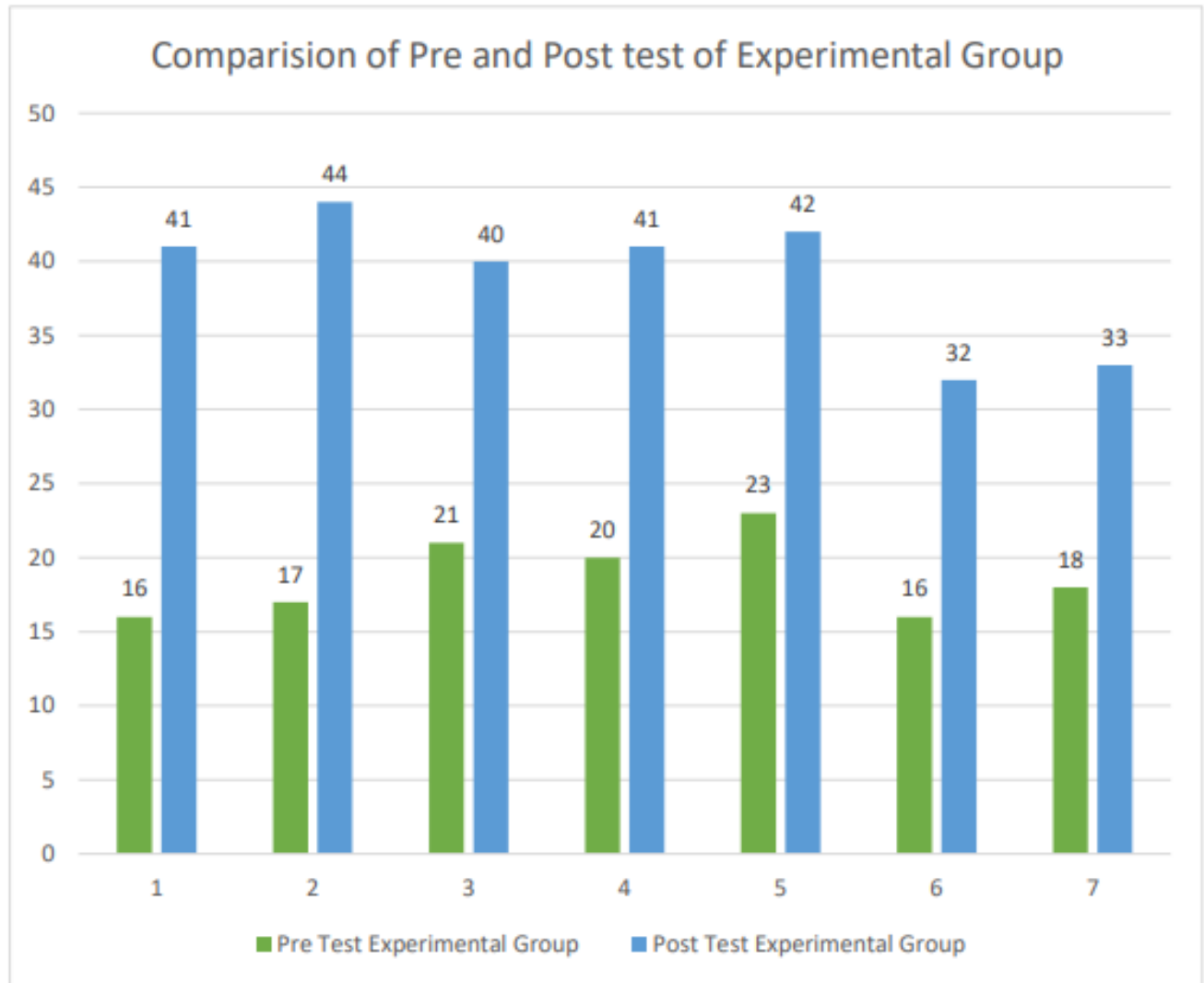
The figure 12 shows the data of number of students attained the particular stage of Kolb’s Experiential Learning Model at Active Experimentation Stage. It can be Observed from the graph that maximum 51.43% of students have attained Developing Stage, while 11.43% students are at the Beginning Stage . 20% of students are at the Accomplished stage and 17.14% of students are at the Proficient Stage of Active Experimentation . Thus it can interpret that the instructional strategy based on Kolb’s Model is effective in developing the Active Experimentation Skill of the students.

Figure 13. Component wise Rubric Analysis of Active Experimentation Stage



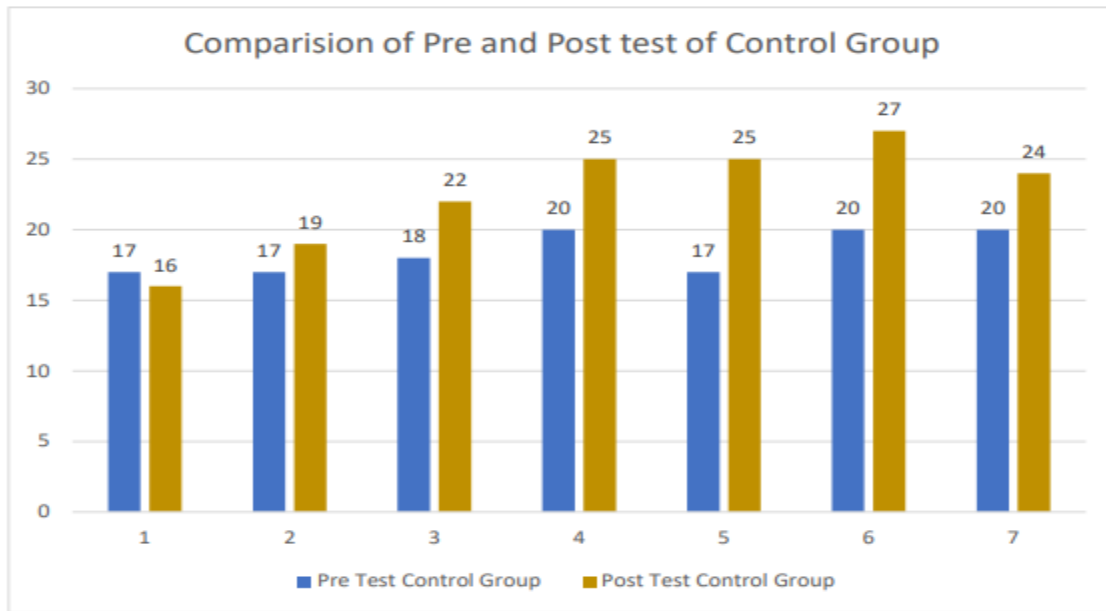
Findings from the Situational test

Figure 14. Comparison of Pre and Post test of Experimental Group



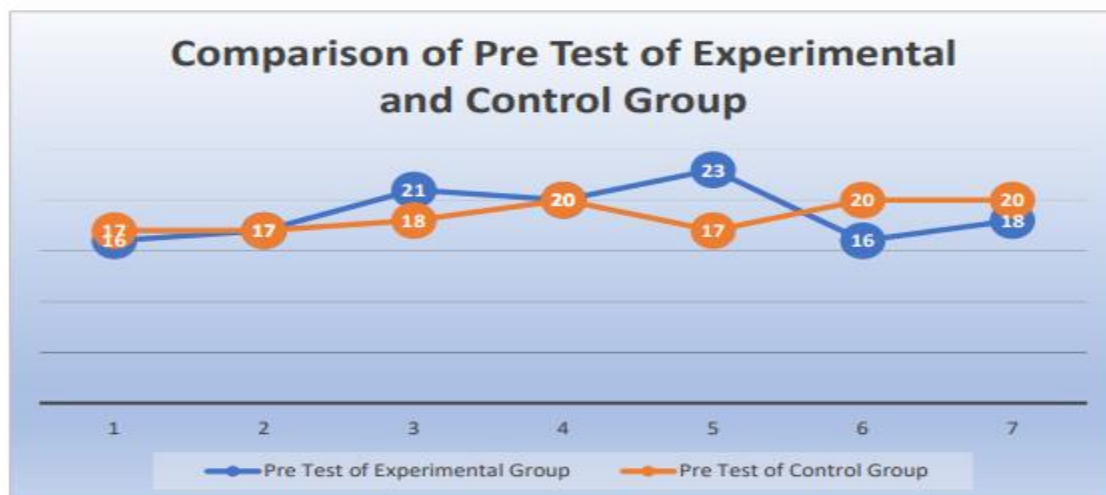
The figure 14 indicates the comparison of pre and post-test of experimental group. The graph shows the increment in the post test of experimental group than the pre- test of the experimental group of all the seven students. The increment was seen much in the post test of all the students of the experimental group than the pre-test of the experimental group. The maximum increment in the post-test from the pre-test is seen in the student number 2 of the experimental group as seen in the graph. Thus, from the graph it can be identified that the instructional strategy based on Kolb’s Experiential Learning Model is effective.

Figure 15. Comparison of Pre and Post Test of Control Group



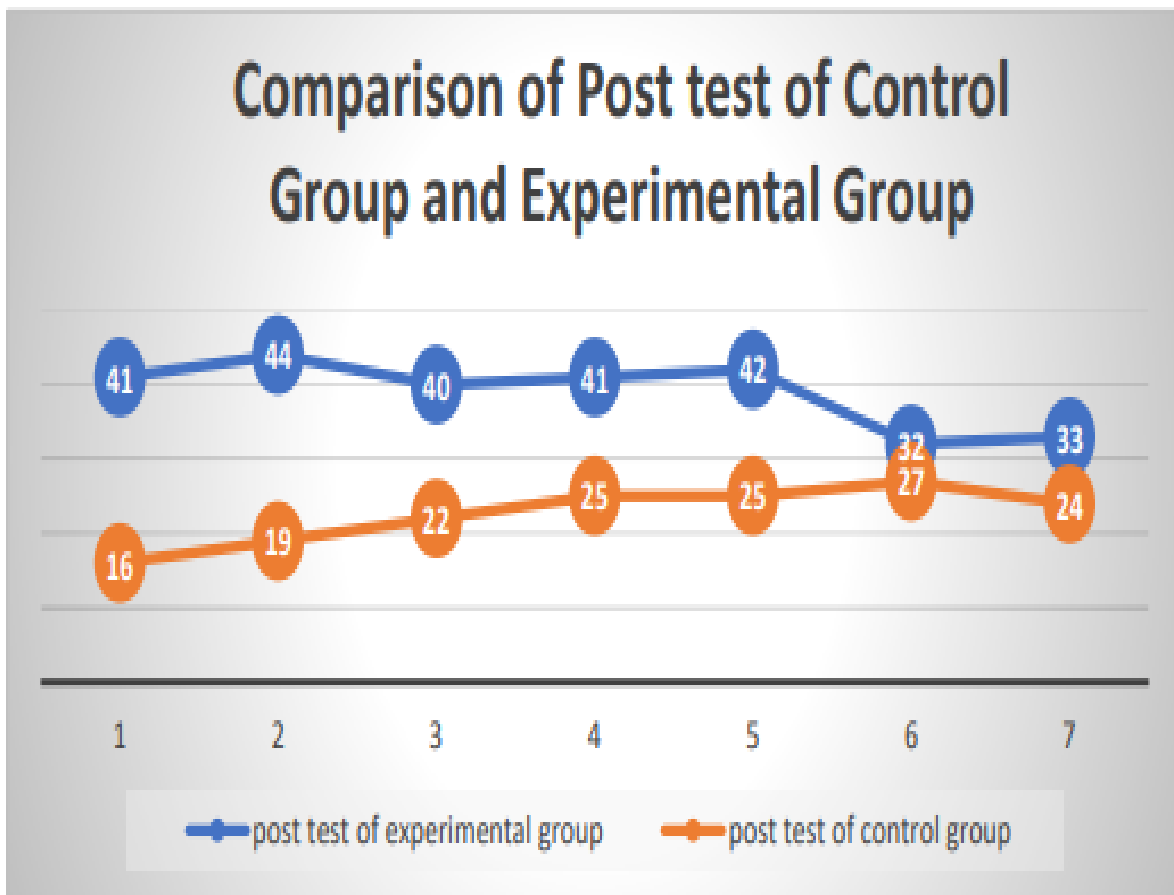
The figure 15 indicates the comparison of pre and post-test of Control group. The graph shows that there is little or no increment in the post test of controlled group than the pre-test of the controlled group of all the seven students. The difference in the pre and post-test of controlled group is much lesser than the difference in the pre and post-test of experimental group. Thus, from the graph it can be identified that the instructional strategy based on Kolb’s Experiential Learning Model is effective.

Figure 16. Comparison of Pre-Test of Experimental Group and Control Group



The figure 16 indicates the comparison of Pre-Test of Experimental and Control Group. It can be interpreted from the graph that the students in the Control and the Experimental Group have nearly equal points in the pre-test of the situational Test. Thus it can be concluded that the students in both the groups are of equal level as the students are randomly selected from the naturally formed cluster in the school of standard 8th.

Figure 17. Comparison of Post Test of Experimental Group and Control Group



It can be interpreted from the figure 17 that there is much increment seen in the post test of experimental group than the Post Test of the Control Group. There is increment seen in the points of all the seven students.

From the above graph it can be interpreted that the students of experimental group have developed in total the 75% of the levels in each stage of the Kolb’s Experiential learning Model whereas the students of control group have developed in total the 43.40% of the levels in each stage of the Kolb’s Experiential learning Model in the post test of both the groups.

Hypothesis Testing

Table: 3. Hypothesis Testing

Mean score of Pre-Test of Experimental group	Mean score of Post Test of Experimental group	Mean gain score of Experimental groups	Mean score of Pre-Test of Control group	Mean score of Post Test of Control group	Mean gain score of Control Group
18.71428571	39	20.285	18.42	22.57	4.14

From Critical Values of the Mann Whitney U (two tailed Testing) we got, T Critical = 4 at 0.01 Level for n_1 & n_2 .

So here, $U < T_c$. Thus, Null Hypothesis is REJECTED and Research Hypothesis H1 is ACCEPTED.

From the above table it can be interpreted that there is gain in the mean score as the score of post-tests is much more than the mean score of the pre-test of both experimental and the controlled group.

From the above table it can be concluded that the Mean gain score of Experimental groups is 16.145 points higher than the Mean Gain Score of the Control Group. Thus, the H1 hypothesis is accepted.

Findings of Objective 3:

The findings reveal a significant positive student reaction toward experiential learning of Kolb’s Model across all statements, as indicated by chi-square values exceeding the table value (5.99) at a 0.5 significance level. Students strongly agreed that experiential learning helped them clearly understand scientific concepts, made learning enjoyable and interesting, and enhanced their application skills. They felt more involved and preferred it over traditional methods. Students enjoyed working collaboratively, doing experiments, and completing tasks. Furthermore, they disagreed with statements suggesting experiential learning was difficult, boring, or confusing, indicating it was well-received and effectively implemented.

SUGGESTIONS FOR FURTHER RESEARCH

1. More research is needed on acquisition of conceptual understanding through experiential learning.
2. Research is also needed in the area of acquisition Conceptual Understanding in Science through experiential learning by taking large sized samples.
3. Research is also needed to be replicated taking same subject for the study.
4. Further research needed to explore by taking all other grades and geographical area.
5. Further study needs to conduct in the area of acquisition of Conceptual Understanding in another subject too.
6. Research and development are needed to study the effectiveness of experiential learning in science and other subjects.

CONCLUSION

Science is not only a collection of facts but also a method for applying knowledge (NCERT, 2005). Teaching science in schools plays a vital role in building students understanding and promoting scientific thinking. Greater emphasis should be placed on the process of learning rather than solely on outcomes, (National Curriculum Framework, 2005). Conceptual understanding serves as the base for growth across all scientific domains, and when fostered early, it helps students develop knowledge, skills, and attitudes (Bybee, 2010). Traditional lecture-based approaches are insufficient for this; instead, incorporating simple experiments, hands-on activities, and experiential strategies enhances learning. Although experiential learning may require more time, it leads to deeper understanding and increased engagement, ultimately strengthening students' conceptual foundations in science (Kolb, 1984).

REFERENCES

- 1) Beard, C., & Wilson, J. P. (2018). *Experiential learning: A handbook for education, training and coaching* (3rd ed.). Kogan Page.
- 2) Brooks, J. G., & Brooks, M. G. (1999). *In search of understanding: The case for constructivist classrooms* (2nd ed.). ASCD.
- 3) Bruner, J. S. (1966). *Toward a theory of instruction*. Harvard University Press.

- 4) Bybee, R. W. (1997). *Achieving scientific literacy: From purposes to practices*. Heinemann.
- 5) Crowder, N. A. (1962). *The psychology of learning*. Grune & Stratton.
- 6) Dewey, J. (1938). *Experience and education*. Macmillan.
- 7) Driver, R., Guesne, E., & Tiberghien, A. (1985). *Children's ideas in science*. Open University Press.
- 8) Fosnot, C. T. (2005). *Constructivism: Theory, perspectives, and practice* (2nd ed.). Teachers College Press.
- 9) Gagné, R. M. (1977). *The conditions of learning* (3rd ed.). Holt, Rinehart and Winston.
- 10) Hodson, D. (1996). Practical work in school science: Exploring some directions for change. *International Journal of Science Education*, 18(7), 755–760. <https://doi.org/10.1080/0950069960180702>
- 11) Köhler, W. (1929). *Gestalt psychology*. Liveright.
- 12) Kolb, D. A. (1984). *Experiential learning: Experience as the source of learning and development*. Prentice Hall.
- 13) Lederman, N. G. (2007). Nature of science: Past, present, and future. In S. K. Abell &
- 14) N. G. Lederman (Eds.), *Handbook of research on science education* (pp. 831–879). Lawrence Erlbaum Associates.
- 15) National Research Council. (1996). *National science education standards*. National Academies Press. National Council of Educational Research and Training. (2005). *National Curriculum Framework 2005*. Author.
- 16) Piaget, J. (1952). *The origins of intelligence in children*. International Universities Press.
- 17) Piaget, J. (1970). *Science of education and the psychology of the child*. Orion Press.
- 18) Rogers, C. R. (1969). *Freedom to learn*. Merrill.
- 19) Skinner, B. F. (1953). *Science and human behaviour*. Macmillan.

- 20) Skinner, B. F. (1958). Teaching machines. *Science*, 128(3330), 969–977. <https://doi.org/10.1126/science.128.3330.969>
- 21) Thorndike, E. L. (1932). *The fundamentals of learning*. Teachers College, Columbia University.
- 22) Watson, J. B. (1913). Psychology as the behaviourist views it. *Psychological Review*, 20(2), 158–177. <https://doi.org/10.1037/h0074428>
- 23) Wertheimer, M. (1923). Laws of organization in perceptual forms. *Psychologische Forschung*, 4, 301–350. <https://doi.org/10.1007/BF00410640>