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A CONTRIBUTION OF CONCEPT MAPPING TOWARDS THE REASONING ABILITY AND PROBLEM-SOLVING ABILITY IN SCIENCE

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Abstract:

Students' grasp of the complexity of concepts and their links was assessed using concept maps. The dynamic nature of the learner, the topic, and the environment make it important to develop a constructivist method that also places a strong emphasis on meaningful learning when delivering science instruction. In order to evaluate this assertion and determine how frequently using concept maps in Noble public school affects the complexity and interconnection of concepts outside of scientific courses, this study had two goals. Students in the IX level at Noble Public School in Meerut, Uttar Pradesh, served as the study's subjects. Concepts mapping techniques' effects on students' achievement and problem-solving skills have been researched. According to the needs of the investigation, the researcher used an experimental research design. To analyse the stated aims and get the conclusions, appropriate statistical methods and tools were employed. The study's findings unmistakably showed that concept mapping techniques improve students' ability to retain and comprehend the supplied content. This approach aids in cultivating students' interest in science as well as their capacity for reflection, planning, and control over the learning process. Additionally, the use of concept maps repeatedly has the potential to make student concept maps more sophisticated and integrated, which will enhance their comprehension of science regardless of the specific science subject.

Keywords: Concept Mapping, Reasoning ability, Problem solving ability, Science students, Critical thinking skills.

1. Introduction:

Today, across the educational spectrum and particularly in regard to higher and professional education, critical thinking (CT) is a highly valued educational result. The concept of critical thinking is being embraced by nursing education systems all over the world, and it is recognized that it is crucial to elicit the (1) evidence of critical thinking in nurses' reasoning process.

Students' grasp of the complexity and interrelationships of concepts was assessed using concept maps. They are visual representations of the concepts and relationships and consist of concepts contained in circles or boxes and connected by a line to demonstrate the relationship between the two concepts. The central goal of utilizing concept maps has been to address significant associations between concepts as suggestions, which are two concepts associated by at least one words. Many investigations discovered that concept mapping revealed the students' degree of knowledge and misconceptions while assisting students in internalising new, important concepts and integrating them with prior knowledge. Students can benefit from using concept maps to (a) organize their thoughts, (b) illustrate the interconnections between essential concepts in a logical fashion, (c) reflect on their understanding, and (d) analyze the connections between the science words they are learning. Concept maps also showed how well students understood the connections and links between previously learned concepts as well as the concepts that still needed to be taught (A. O. Fatoke, 2013).

Science is a body of acquired knowledge that is organized and limited to natural phenomena. Science is a cumulative and never-ending series of scientific observations that lead to the development of conceptions and theories, both of which are susceptible to change in response to new empirical observations. Science is the process of learning new things as well as a body of information. Science is depicted in the first aspect as a finished good, but science is depicted in the second aspect as a process.

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1.1. Background of the study

Education has always been seen as a tool for bringing about societal change. Without improving the teaching methods in the classroom, this goal cannot be achieved. Teaching is an activity that is planned and carried out to achieve a variety of goals in terms of behavioural changes in students, which also includes a complex array of attitudes, knowledge, skills, motivation, and values. Different from simple teaching is effective teaching. Effective teaching and learning do not rely on a single approach. Engaging and intelligent learning result from effective instruction. It can also include offering directions, guiding students through their studies, providing knowledge, and other things besides just getting them to know and grasp something. Additionally, it directs and facilitates learning, enables the learner to learn, and creates the right environment for learning.

Joseph created the concept mapping (CM) method in the 1970s as a way to visualise the connections between various concepts. CM is one of the academic teaching methods that has been shown to be effective in fostering active learning. Numerous studies have been done to determine how well CM fosters critical thinking abilities (B. Utami, 2017).

1.2. Concept Mapping

A concept map is a visual tool for enhancing comprehension and meaningful learning through the activation and expansion of past knowledge. Concept Mapping (CM) encourages conceptual comprehension and problem-solving procedures. A idea map is a practical tool for organising and remembering information. Because students learn more quickly and effectively when they can connect and integrate new knowledge with old knowledge, activating prior knowledge is a crucial component of learning. Concept maps are practical tools for independent learning that display the student's cognitive framework. They are dynamic and alter as pupils' knowledge increases.

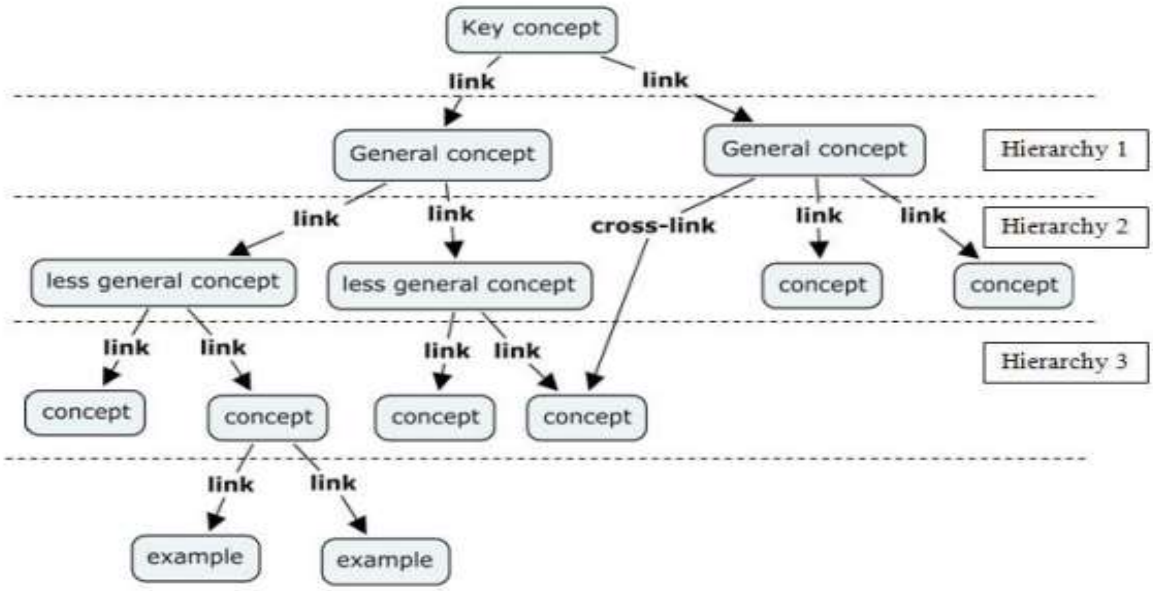

Figure 1: Model of a Concept Map

Concept mapping is a teaching and learning method that uses visual representations to show how concepts and ideas relate to one another. Concepts are linked by words and phrases that explain the connections between the ideas, which are frequently represented as circles or boxes. This aids students in organizing and structuring their thoughts to better absorb material and uncover new correlations. A concept map is a type of hierarchical structure diagram that shows the relationships

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between general and specific concepts within a certain topic. It is made up of idea labels, also known as nodes or cells, which are connected by directions-labeled lines. A concept map, sometimes referred to as a flow chart, is frequently used in business to get perspective on the big picture and to generate fresh concepts and innovations (C. Carvalho, 2015).

2. Review Of Literature:

A recent report by D. Alhaddabi tried to decide what the concept maps strategy for logical guidance meant for the science accomplishment of 6th grade female students in the Essential training program in the Republic of Yemen's capital, Sana'a. The research sample included two groups of (30) female students each, totaling 60 female students. While the benchmark group got standard guidance, the trial bunch got guidance using concept maps. The study's findings revealed a sizable statistical difference in the experimental group's favor in terms of science achievement (Alhaddabi, 2011).

The impact of concept maps on students' accomplishment retention in organic chemistry was examined by Ezeudu, F.O. (2013). The study's design was a quasi-experiment. 435 students made up the sample. The students' performance and retention in organic chemistry were significantly impacted by the usage of concept maps. Therefore, concept maps were a more effective teaching tool for organic chemistry than lectures. The achievement and retention of the students in organic chemistry were not significantly impacted by gender. Therefore, utilizing concept maps, both male and female students demonstrated the same degree of accomplishment and retention in organic chemistry (Ezeudu., 2013).

Using idea mapping as a meta-cognitive method, Aziz, T., and Rahman, A. (2014) investigated if science achievement at the secondary level was improved. This experimental study included 120 class IX students from two senior secondary schools in Delhi. The study's quasi-experimental design used a pre- and post-testing approach to ascertain the concept mapping strategy's impact on students' science achievement. The study's findings demonstrated that the idea mapping strategy was superior to the lecture and discussion method for raising students' science achievement (Aziz, 2014).

The impact of adopting the idea mapping approach in the classroom on the science achievement of fifth graders was examined by Qarareh, A.O. (2017). To do this, 80 students were chosen at random and split into two groups: the trial bunch got guidance utilizing concept mapping, while the benchmark group got guidance utilizing the regular strategy. The following two tools were used to gather data: -a variety of instructional scenarios that were planned using a concept map and an achievement scale with 25 items. Analysis of variance was utilized to provide answers to the study's questions. According to the study, using idea maps has a stronger impact on academic attainment. The researcher suggested that idea mapping be employed in science instruction and that more research be done on this method's effects, taking other instructional factors into account (Qarareh, 2017).

The concept mapping instructional strategy was investigated by Ameyaw, Y., and Okyer, M. (2018) as a performance enhancer for students in the teaching and learning of excretion. For this investigation the consequences of the review showed that the concept mapping post-test scores of the students had a bigger impact size than the pre-test scores. The teaching strategy not only helped students perform better in the biology course, but it also helped them retain the information longer (Ameyaw, 2018).

A study was undertaken by Seham, A., and Elmeyazen, S. (2018) to determine the impact of concept mapping on undergraduate nursing students' knowledge, clinical competence, and problem-solving abilities. Data were gathered from the labs of the Clinical and Careful Nursing Office and the Local area Wellbeing Nursing Division at Tanta University's Faculty of Nursing using a quasi-experimental method. A sample of 60 first-year nursing students was chosen at random from the group. As a result of this study, students' understanding of concept maps, simulation case study rubric, and problem-solving abilities all significantly improved. Additionally, more than three quarters of students had favorable opinions of the use of concept mapping in clinical settings. Following the use of concept mapping in the clinical context, there were notable improvements in knowledge, simulated case study rubric, and problem-solving abilities scores (Seham, 2018).

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2.1. Statement of the problem

Study objectives included determining the influence of concept mapping on students' achievement and problem-solving skills in the science topic as well as the contribution of concept mapping as a teaching approach in the reasoning and problem-solving skills of Noble public school students in Meerut. Consequently, the study's title is "A Contribution of Concept Mapping towards the Reasoning Ability and Problem Solving Ability in Science".

2.2. Significance of the study

Complex theories and ethereal conceptions make up science. Traditional methods of teaching science do not convey enough knowledge to prepare students' minds for analysis and learning. With these instructional techniques, the students are unable to comprehend and do not meet the intended objectives. Quite possibly of the main subject in the school educational program is the instructing of science at the auxiliary level. The current approach solely encourages passive study in the sciences. There is still a lot of effort to be done in understanding how students' ideas grow over time, what influences channel and regulate this development, and how learning science is dependent upon prior knowledge. An ongoing, progressive research programme about the integration and consolidation of students' learning is made possible by the findings of the current study.

2.3. Objectives of the study

The accompanying objectives were put together to satisfy the review's motivation:

- To ascertain whether there was a genuinely tremendous distinction in the mean scores on the Pre- and Post-tests for Achievement and Problem-Solving Abilities for Concept Mapping Strategy for Noble Public School's ninth grade students.
- To ascertain whether there is a substantial difference in the Noble public school ninth-class students' achievement and problem-solving ability mean scores between the Pre-test and Post-test.
- To contrast the problem-solving skills of science students who get instruction using Concept Mapping Strategy (CMS) with those of students who receive instruction using traditional teaching methods (CTM).

3. Proposed Methodology

A quantitative research methodology was utilized to examine how science units and concept maps evolved in complexity over time. The study's participants were the ninth-grade students from Noble Public School in Meerut, Uttar Pradesh. Teachers and students are the data providers. Action research involves conducting data analysis throughout the entire data collection process. A descriptive method is used to process and interpret the data from the research findings. The triangulation in this study takes into account discussion, concept maps, and test findings.

3.1. Research Design

An examination configuration is an assortment of methods and techniques used to assemble and look at information on factors that are referenced in the exploration challenge. This makes it possible for the researcher to draw reliable conclusions regarding the connections between independent and dependent variables. The selection of the best experimental design depends on the objectives of the study, the types of variables to be used, and the constraints that the study must adhere to. Concept mapping is used as an independent variable in the current study, whereas achievement and problem-solving skills are used as dependent factors. To investigate how ninth-class students' achievement and problem-solving skills are affected by concept mapping methodologies in science.

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3.2. Sampling Design

The Purposive Sampling approach was used. Students in the IX standard at Meerut's Noble Public School made up the study's population. Purposive sampling was used to choose 100 pupils from the IX standard and divide them into the Control group and Experimental group groups.

3.3. Statistical Tools

The procedure of gathering data was followed by its analysis and interpretation.

Descriptive statistics: Using descriptive statistics, it was possible to investigate the characteristics of the variable scores. For this reason, values for the dependent variables' pre-test and post-test scores' means, medians, standard deviations, kurtosis, and skewness were computed.

t-test: The t-test was utilized to decide if the mean scores from the pre-test and post-test contrasted. The matched t-test was acted in the ongoing examination.

One way ANOVA: To compare the major differences in achievement and problem-solving skills between groups.

3.4. Data Collection Procedure

In order to get to conclusions about the formulated hypotheses, it is crucial in a scientific inquiry to gather some evidence using data collection techniques. The data for the current study was gathered using an experimental approach. For the specified investigation, the researcher used a "Randomized experimental group (concept mapping) and control group (conventional method) pre-test post-test design." The entire experiment was planned in advance. Achievement tests and tests of problem-solving aptitude were also created, and appropriate instruments were chosen in advance. Through the use of the appropriate methods, the researcher evaluated the impact of the independent variable, concept mapping, on the dependent variables, achievement and problem-solving ability.

3.5. Hypothesis

- There will not be a discernible change in the ninth-grade students' mean pre- and post-test scores in achievement, problem-solving skills, or concept mapping strategy.
- There will be no appreciable difference in the ninth-class students' achievement and problem-solving ability between the Pre-test and Post-test average scores.

4. Data Analysis and Results:

4.1. The nature of problem-solving skills pre-test and post-test scores

One of the dependent variables in the current study was problem-solving abilities. According to the goals of the study, the Problem Solving Ability pre-test and post-test results for the Experimental and Control groups were collected.

➢ Pre Test Scores

The mean, median, kurtosis, and skewness values of the problem-solving pre-test scores for the E and C groups were computed using descriptive statistics. The nature of the pre-test results for problem solving skills and their interpretation are shown in table 1.

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Table: 1. the type of PSA the experimental and control groups' pre-test results

Groups	Mean	Median	S.D	Kurtosis	Skewness
Experimental group (Concept Mapping)	9.61	11	2.72	-0.819	-0.122
Control group (Conventional teaching method)	9.55	11	2.86	-0.342	-0.247

The experimental group's mean, median, and S.D of the Problem Solving Ability (Pre-Test) scores are shown in Table 1 and are claimed to be 9.61, 11 and 2.72, respectively. The scores are distributed regularly since the mean and median values are roughly equal. Additionally, it is clear from the results that the experimental group's kids have very limited problem-solving skills. A mean value of 9.55, a median of 11, and an SD of 2.86 has been reported for group C (Control). The scores are regularly distributed, as seen by the proximity of the mean and median values. Additionally, it shows that pupils in the control group scored very poorly on the pre-test for problem-solving skills.

- **Post Test Scores**

Additionally, ninth-grade science students' post-test scores on their capacity for problem-solving were gathered for the E and C groups, respectively. The measurements of central tendency, kurtosis, and skewness were used to test the normality of the score distribution. The data for the mean, median, S.D., kurtosis, and skewness of the Problem Solving Ability Post-test scores regarding the two groups, shown in the underlined table (experimental and control).

Table: 2. the type of problem-solving skills Post-test results for the E and C groups

Groups	Mean	Median	S.D	Kurtosis	Skewness
Experimental group (Concept Mapping)	14.92	15.02	3.36	-0.866	-0.116
Control group (Conventional teaching method	9.76	11.02	2.69	-0.410	-0.371

The mean, median, and S.D. values for the experimental and control groups' scores on the post-test measuring problem-solving ability are shown in Table 2. The experimental mean, median, and S.D. values are 14.90, 15.02, and 3.36, respectively. The values show that the results are regularly distributed. Additionally, it states that the experimental group's kids have strong problem-solving skills. The pupils in Group C (Control) had a mean score of 9.76, a median of 11.02, and a standard deviation of 2.69. The closeness of the ratings suggests that they adhere to normalcy measures. It further demonstrates the kids' poor problem-solving skills.

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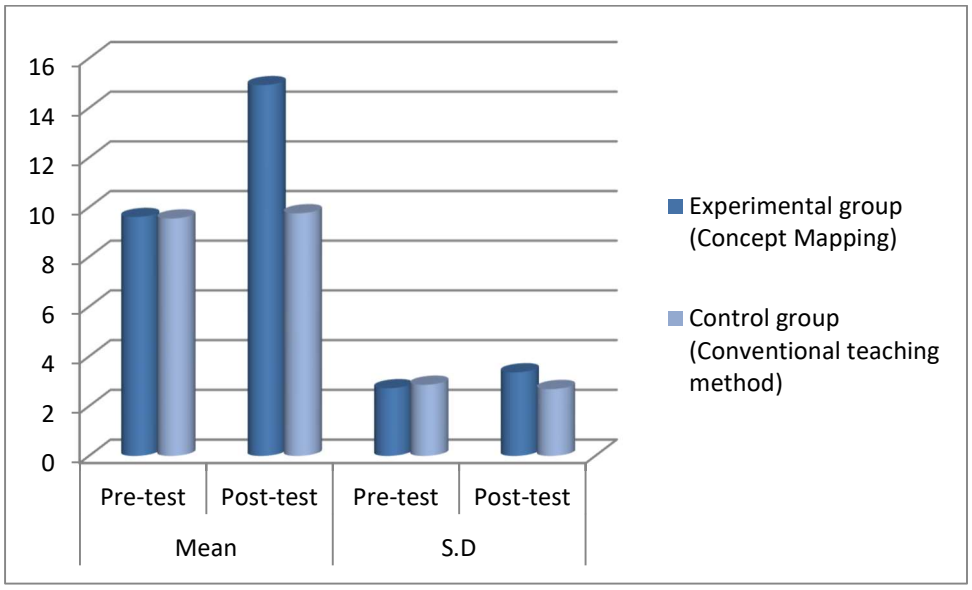

Figure 2: Comparison of mean and S.D of pre and post-test results for the experimental group and the control group

4.2. Students' achievement and PSA mean scores before and after the experimental group test (Concept Mapping)

As a result, the researcher used the suitable methodologies and methods to systematically investigate the tremendous contrast between the pre-test and post-test mean scores of students in Achievement and Problem solving ability for the experimental group (Concept mapping Experimental group). The associated tables and graphs are shown as follows.

Table 3: Student achievement and problem-solving ability (PSA) mean scores for the experimental group (Concept Mapping) at pre-test and post-test

Variables	N	Mean scores (Pre-test)	Mean scores (Post-test)	t-value	p-value
Achievement	100	29.13	50.80	23.326	0.000*
Problem solving ability (PSA)	100	9.61	14.92	28.196	0.000*

* 'p' value significant at 0.01 level

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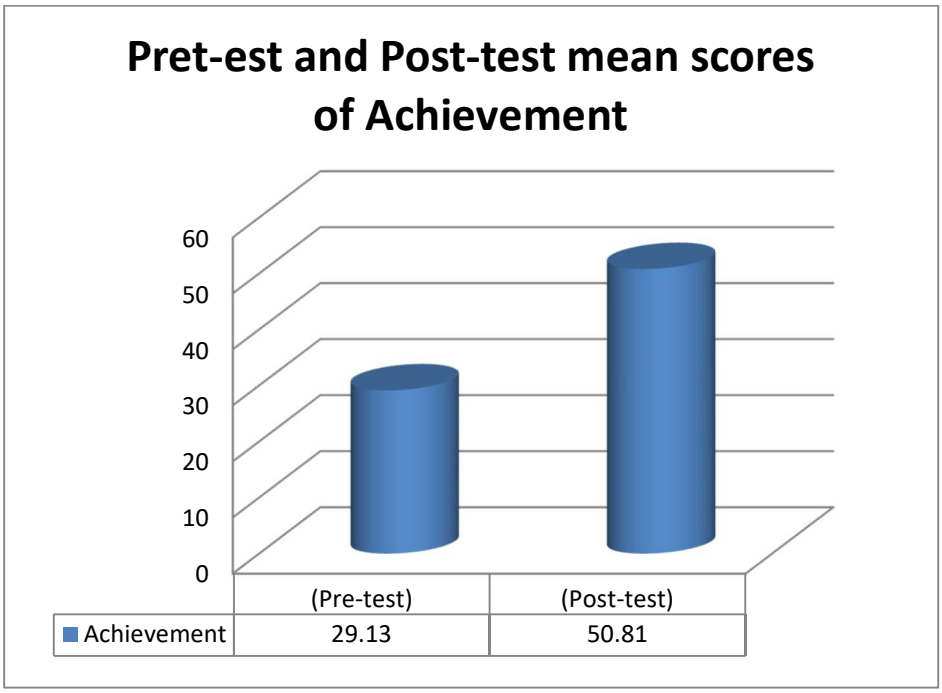

Figure: 3. An illustration of the students' achievement for the Concept Mapping Experimental group's pre- and post-test mean scores

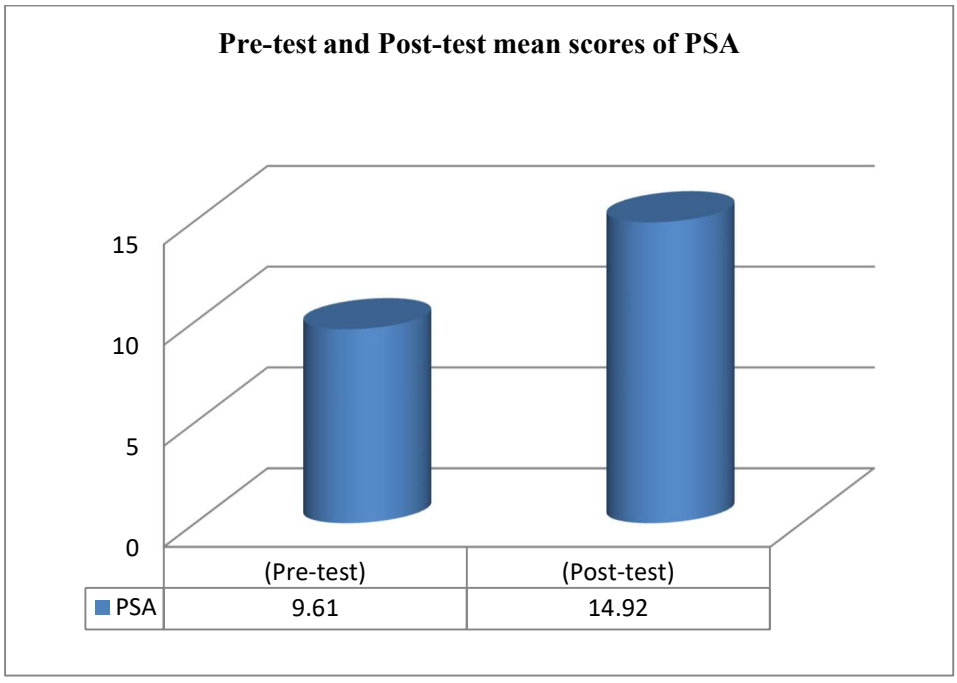

Figure: 4. Illustration of the students' mean problem-solving ability from the pre- and post-tests for the experimental group using concept mapping

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The achievement and problem-solving ability mean scores for IX standard pupils are shown in Table 3 and Figures 3 and 4. The equivalent achievement and problem-solving ability pre- and post-test mean scores are (29.13 and 50.81) and (9.61 and 14.92), respectively. The table also shows that the experimental group's t-values for achievement and problem-solving capacity are 23.226 and 29.096 respectively, which are statistically significant at the 0.01 level of significance.

4.3. Students' achievement and problem-solving skills (PSA) pre-test and post-test mean scores for the control group

The impact of conventional teaching methods on pupils in Noble Public School's ninth grade in terms of achievement and problem-solving skills was to be assessed, following the stated purpose. The table that follows demonstrates the considerable difference in students' achievement and problem-solving ability mean scores between the pre-test and post-test for the Control group.

Table: 4. Students' achievement and problem-solving skills (PSA) pre- and post-test mean scores for the control group (Conventional teaching method)

Variables	N	Mean scores (Pre-test)	Mean scores (Post-test)	t-value	p-value
Achievement	100	26.25	26.61	2.916	0.076
Problem solving ability (PSA)	100	9.54	9.75	3.610	0.016

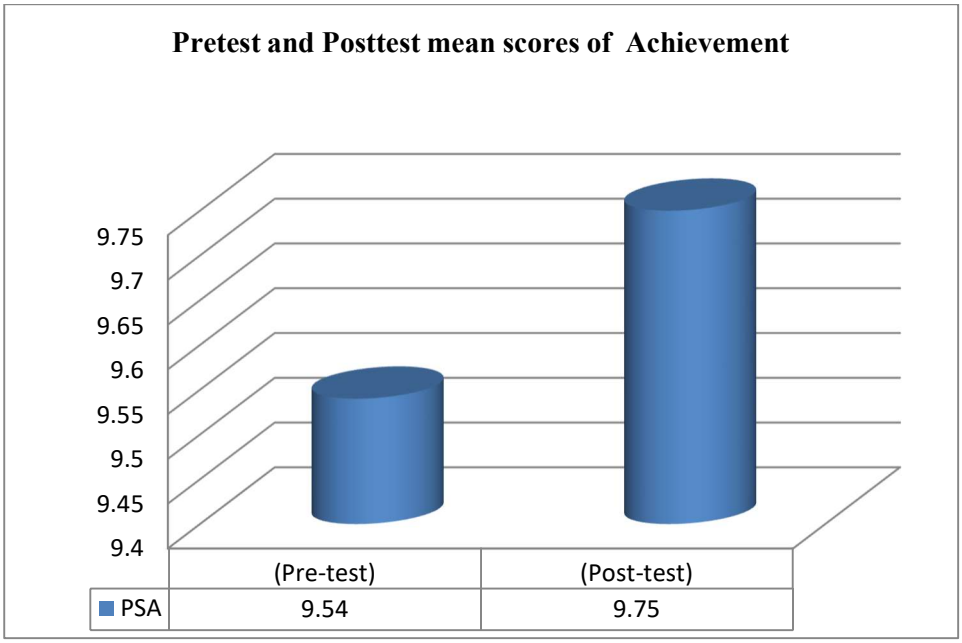

Figure: 5. Student achievement for the Control group's pre- and post-test mean scores are represented graphically.

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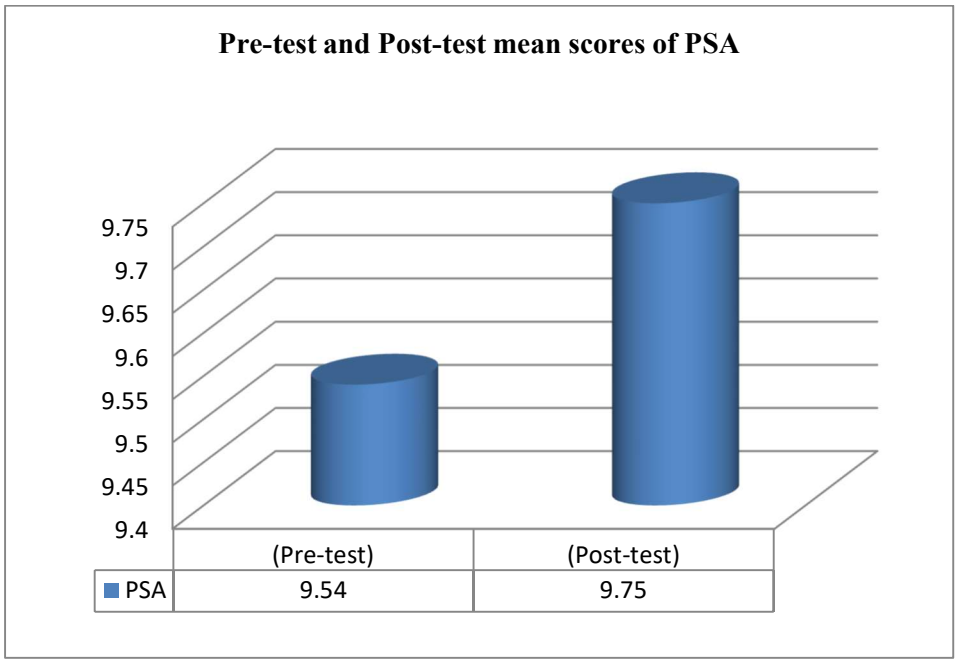

Figure: 6. the mean PSA scores of students' pre- and post-tests are represented graphically for the Control group

The pre-test and post-test mean scores of students in Achievement and Problem solving ability for the Control group are ostensibly displayed in Table 4 and Figures 5 and 6. Students' achievement and problem-solving ability pre- and post-test mean scores are (26.25 and 26.61) and (9.54 and 9.75), respectively. The table shows that the achievement and problem-solving ability t-values for the Control group are 19.16 and 26.10, respectively. At both the 0.01 and 0.05 levels of significance for Achievement, the "t" value is statistically insignificant. But at a 0.05 degree of significance, the "t" value is said to be significant for problem-solving abilities.

5. Discussion

5.1. Concept mapping's Effect on Achievement

The consequences of the matched "t" test showed that the contrast in comparison to the pre- and post-test was huge. Achievement averages for the experimental group (Concept mapping). At the 0.01 and 0.05 levels of significance, the t-value for achievement was shown to be significant. It showed that after being taught using the concept mapping technique, the students in the test group for concept mapping scored much higher on the achievement exam. The Concept mapping strategy's pictorial and useful character may be the apparent reason for their improved performance at the post-test level. Students learn the concepts by presenting them in a two-dimensional structure, similar to concept mapping. The students coordinate concepts or thoughts in various levelled classifications, with the broadest concept set at the top and the more definite concepts with models set at the base. Through connecting lines and connecting words, general and specific concepts are connected. The students' memories can readily be stored with the use of graphical or pictorial representations of the subject matter. It helps pupils retain, remember, and understand the material for a longer period of time. Thus, following instruction using the concept mapping technique, the students' achievement increased at the post-test level (Watson, 2016).

5.2. Concept mapping's Effect on Problem solving ability

The inferences made from the findings of the paired "t" test revealed that there was a huge distinction between the mean problem-solving ability scores for the exploratory gathering (Concept mapping) on the pre-test and post-test. At the 0.01

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and 0.05 levels of significance, the achieved t-values for problem-solving ability were reported to be significant. Students who received training using the concept mapping technique had significantly improved problem-solving skills at the post-test level as compared to the pre-test level. The concept mapping approach assisted the learners in stimulating and illuminating the existing as well as missing links between the concepts or ideas, which improved the students' ability to solve problems successfully. The students were taught both basic and specialised concepts in order to expand on their prior knowledge and articulate the issue logically and methodically. The correct responses to these linkages demonstrated that increased knowledge has improved one's capacity for problem solving (Wu P-H, 2012).

Based on the statistical analysis, we may sum up the study's findings. The deliberate use of the idea mapping approach revealed to be complacent in improving the cognitive, emotional, and psychomotor learning domains in students. The outcomes clearly show that the concept mapping technique was appropriate for the students' needs.

6. Conclusion

The inferences made make it clear that the general education system has to support a meaningful teaching and learning approach that may address the growing issue of rote learning among pupils. The concept mapping strategy was determined to be efficient and to encourage a relevant approach to the teaching and learning process in light of the research's findings. It turned out to be a way to improve the science achievement and problem-solving skills of Noble Public School's IX grade kids. Concept mapping has been proven to be a helpful and supportive method for learning new information and connecting it to previously acquired information. Additionally, it has been established that Concept mapping significantly impacted pupils' conceptual understanding and intellectual ability, regardless of whether they were girls or guys. Despite this, the approach was responsible for improving students' basic scientific abilities, including curiosity, keen observation, enthusiasm in scientific advancements, and critical and divergent thinking. Students were able to identify their learning objectives, come to terms with them, and work toward each one with the aid of this technique. The application of such a technique has also, in general, improved the order of quality in the distribution of education. Therefore, it is highly advised and necessary to move away from the old lecture style and toward the achievement of meaningful learning using new methods like Concept mapping.

7. Future Scope

For students, educators, researchers, policy makers, curriculum developers, institutional managers, and educational and software programmers, the research has a broader range of consequences. The current study opens up new channels for information and truth. The findings of this study can provide useful direction to the educational community. Through tests in controlled and open groups, in-depth studies have exposed hidden flaws in instructional methodology. We must have a solid educational foundation in our schools if we want to succeed in today's competitive world. It is inevitable that teaching theories and methods will change. In reality, capturing young, impressionable minds in their formative years will set them up for long-term success and personal advantages in both their academic and professional lives.

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