ACADEMIA International Journal for Social Sciences
Volume 4, Issue 4, 2025 ISSN-L (Online): 3006-6638

Impact of Concept Mapping on Students' Academic Achievement at Secondary Schools Quetta

Shoaib Kareem
Shoaibkareembaloch@gmail.com
M.Phil. Education at University of Peshawar

Meerullah
meerullah260@uop.edu.pk
M.Phil. scholar, Department of Statistics University of Peshawar

Muhammad Arslan
Arslankhetran82@gmail.com
MS Project Management Szabist Islamabad Campus

Hussna Aziz
irkakar000111@gmail.com
Research Scholar, Institute of Education and Research, University of Balochistan, Quetta, Pakistan

Muhammad Ismail
ismailfromdir@gmail.com
M.Phil. scholar, Department of Statistics University of Peshawar

Atif Aman
Aman.atif@gmail.com
Alhamd Islamic university Quetta

Arshia Sumbal
arshiasumbal12@gmail.com
B. Ed 1.5, Education University of Balochistan Quetta
Corresponding Author: * Meerullah meerullah260@uop.edu.pk

Received: 15-09-2025 **Revised:** 12-10-2025 **Accepted:** 28-10-2025 **Published:** 12-11-2025

ABSTRACT

This study investigates the effect of concept mapping on students' academic achievement, focusing on its role in enhancing understanding, retention, and overall performance compared to traditional teaching methods. Concept mapping, rooted in constructivist theory and introduced by David Novak, enables students to visualize relationships between concepts, organize information meaningfully, and engage in active learning. Data were collected from a population of 400 students, with a sample of 200 selected through stratified random sampling. A structured Likert-scale questionnaire assessed students' perceptions of concept mapping. Descriptive statistics, correlation analysis, and ANOVA were employed to analyze the data. Results indicate that concept mapping positively influences academic performance, improves comprehension of difficult topics, and fosters student engagement. Significant correlations were observed between concept mapping preference, understanding, and improved academic outcomes, while ANOVA results confirmed meaningful differences among groups. The findings highlight the effectiveness of concept maps as both a teaching and assessment tool, offering educators a practical method to enhance learning outcomes and student engagement.

Keywords: *Concept mapping, Academic achievement, Constructivist learning, Visual learning tools, Student engagement, Knowledge retention.*

INTRODUCTION

Learning is a fundamental human need and a crucial element of a nation's progress. Learning is a decisive, as well as difficult procedure (Lestari et al., 2019). The key characteristic of learning is that, learning contains a multi-layered collaborative coordination surrounding ecological, communal, Self-directed, emotive as well as mental aspects, (Huang et al., 2017). Numerous teaching methodologies have been established to increase the scholar knowledge. Therefore, these learning approaches change from the learning philosophies describing the teacher performance, scholars as well as the subjects. At prevailing time in Pakistan, regularly social performs are in fashion in institutes, where scholars are inactive as well as teacher is dominated in classroom (Koufou, 2016; Hafeez et al., 2020). Therefore, in 2006, National Curriculum emphasized for the pattern change from the behaviorism theory to constructivism approach to develop mental learning in science as well as growth of insolence to science education, (Govt. Of Pakistan Report, 2006). Different learning methodologies are being used across the world, especially in industrialized nations, including computer-based idea mapping (Amemado, 2014). These nations are promoting critical thinking and problem-solving abilities in their students via the use of computer-based learning tools (Ali et al., 2017; Hafeez, 2021). The primary goal of twenty-first-century learning is to assist students in generating valuable and meaningful information that can be used to a variety of creating and addressing real-world issues (Hidding et al., 2018). The globe, with all of its difficulties including speedy development of facts and learning processes, as well as increased demands on the learning system creates an encounter for students to enhance their learning skills in order to compete with these complications. Thus, the primary goal of curriculum in schools, colleges and universities is to promote theoretical and conceptual learning that underlies students' development (Rimini & Spiezia, 2016). David Novak was the first to introduce concept maps (Novak & Gowin, 1984). He created this valuable tool based on Ausubel's learning ideas. A conceptual diagram called a concept map combines several concepts into a single figure. By using connecting words to create meaningful sentences, the concepts are meaningfully connected. Concepts are often depicted in these concept map diagrams as boxes, and the links between them are shown as arrows with joining different words (Ausubel & Barberán, 2002). Concept maps strategies show how students acquire knowledge and apply it to practical issues. The concept maps also help students in accepting the material supplied according on their mental level (Wang et al., 2017). Concept maps are diagrams in two dimensions that show information. Concept maps based on technology are employed in the teaching and learning process nowadays (Chiou et al., 2017). Concept maps can serve as tools to promote links among designs inside and across contexts, which can help to streamline information integration and learning processes. A concept map comprises of nodes, two directional joining lines, and connecting tags that define the connection between nodes. A concept map is made up of two nodes that are linked by a characterized line (Hafeez, 2021). Concept maps (or "Cmaps") are visual depictions of concepts and their relationships and have been consistently heralded as an effective educational tool for nearly 40 years. They consist of concepts, visually represented as terms bound in a circle or square, which are linked to other concepts with lines called crosslinks. These lines are accompanied by a verb or symbol, such as "+" or "- ", which describe the relationship between the two concepts and may include an arrow indicating the relationship's directionality. Concept maps are typically arranged hierarchically, with the main concepts placed at the top of the map and the sub-topics arranged lower down. Successful concept maps usually have a critical question that the map seeks to address (Novak, 2006). Concept mapping is a generic term that describes any process for representing ideas in pictures or maps. In this book, however, we use the term only to refer to one specific form of concept mapping, an integrated approach (Trochim, 1989c; Trochim & Linton, 1986) whose steps include brainstorming, statement analysis and synthesis, unstructured sorting of statements, multidimensional scaling and cluster analysis, and the generation of numerous interpretable maps and data displays. Joseph Novak created concept maps in 1972 when he was a professor at Cornell University. He was trying to understand how students' understanding of science changed as the student acquired additional knowledge. He found that interview transcripts were unsuccessful in explaining the complex processes through which students assimilated new information into their previous knowledge structures. His belief in the usefulness of concept maps was based on constructivism, or the idea that humans construct knowledge by incorporating new information and experiences into what they already know (Novak, 2006). Novak (2006) established the basic concept map creation process. First, one should start with a good focus question, whether provided by the teacher or the learner. The more focused and robust the question, the better the resulting concept map. Second, one should identify key concepts having to do with the topic question, list them, and rank them in order of importance. Next, one should construct a preliminary map with the central concepts near the top and sub-topics arranged below, with crosslinks between them.

Using concept maps as a stage in the learning process is the most frequent use of concept mapping (Lomask, Baron, Greig, & Harrison, 1993; Ruiz-Primo & Shalveson, 1996; Wilson, 1993). This is because creating concept maps helps students learn (Novak, 2006). Concept mapping contributes to student confidence by letting students demonstrate what they know rather than forcing them to explain what they don't know as in traditional testing. The process helps encourage meaningful learning and creative thinking and replaces rote learning and memorization. The creation of crosslinks encourages students to define the precise relationship between concepts, which requires creatively synthesizing and evaluating information (Kinchin, 2001). Further, concept mapping can be a useful learning tool when used in collaborative group work. It can help a group stay on task by giving them a concrete goal to work towards, rather than an abstract problem to figure out. It has been shown that just working on a concept map as a team increases group cohesion and morale (Trochim, 1989). Concept maps prove useful when evaluating student comprehension, so much so that they have started to appear as an evaluation tool in science textbooks (Novak, 2006). Teachers are able to identify valid and invalid points through student-generated crosslinks, and evaluate the complexity of a student's understanding through the number and breadth of concepts. Traditional types of assessment tend to focus on individual concepts rather than the relationships between concepts, ignoring a great deal of the disciplinary knowledge that a student has mastered. Concept maps are also practical since they provide comparable results to traditional testing while requiring less time and little training for instructors (Markham, Mintzes & Jones, 1994). Further, they provide an equitable testing method for students who suffer test anxiety (Okebukola & Jegede, 1989). Concept maps are grounded psychologically and epistemologically. They are based on the Theory of Learning Psychology of David Ausubel (1963), which states that students learn through assimilating new ideas into their existing framework and cognitive structure. Epistemologically, it has been shown that concept maps help provide the mental scaffolding with which students structure new knowledge (Novak, 2006). Creating concept maps helps increase student retention of new information (Novak, 1990; Novak & Wandersee, 1991). Additionally, studies have indicated that conclusions gained when concept maps are used as an evaluation tool are comparable to traditional testing methods (Shavelson & Ruiz-Primo, 2000). Despite the fact that they were created nearly 40 years ago, concept maps remain "the most important meta-cognitive tool in science Education today" (Mintzes, Wandersee, & Novak, 1997, p. 424).Concept Maps in Education If concept maps are correctly created it is a very strong way for students to achieve higher levels of cognitive performance. It is not just a tool for learning, but a perfect tool for the evaluation of educators to measure their growth and evaluating learning of students. As students create concept maps, they create ideas using their own words and help to identify incorrect ideas and concepts. Educators are able to see what students do not understand, providing an accurate, objective way to evaluate areas in which students do not yet grip concepts fully Concept Map as a Teaching tool Lee at all (2012) stated that the usage of concept maps as a teaching approach was first developed by Novak in the early 1980's. It was resultant from Ausubel's learning theory which puts focus on the impact of students' previous knowledge on significant learning. Safdar (2010) describes that if teachers learn how to generate concept maps and use them for preparation and measuring lessons, they will be able to communicate students better how to create concept maps to establish their opinions and philosophies in the classrooms. In specialized education the method of concept mapping is used typically for teaching and for assessment. We could not find the use of concept mapping for free associating or information organization in the occupations so it does not mean the implementation is not there in the classrooms. Concerning concept mapping in specialized education the focus was on learning and the use of concept mapping as a knowledge tool. Concept mapping as a method was involved in lots of ways, instructional stages and activity practices. Furthermore, to use as a learning tool in professional education it is also commonly used as an assessment device. Concept maps are significantly used for assessments through which teacher can self-assess themselves. Novak (1991) stated that Concept maps are repeatedly used as learning and study instrument in the sciences. Concept maps as a learning instrument used in the areas of biology, physics, engineering, nursing and algebra. Concept maps are also being used as device to train pre-service and current working teachers. Because they involve little amount of written text and concept maps may be typically effective apparatuses for students with low verbal abilities. Making concept maps at the conclusion of a unit or lesson is a more actual learning plan than using them to display concepts at the start of a lesson for student's long-lasting retention of the material (Nesbit & Adesope, 2006). Concept map should complete minimum three rounds of revision so that students can attain practice. They are more effective summary creation learning plans, such as making lists or frameworks and to comprehend the associations between important concepts, may be likewise considered. Concept maps are useful tools to help students learn about their knowledge organization and the process of knowledge building. Concept maps also help the student to learn manifold learning. Concept mapping necessitates the learner to inculcate at cognitive domain of bloom. Concept Maps have been used to check students' previous information and to keep stream line the student's progress of knowledge in entire development for matching and doing comparisons of students at numerous stages of knowledge. Other uses of concept maps Empirically based publications shown that concept maps have been used in quantitative and qualitative studies; in qualitative approaches used throughout all stages of the research process while in quantitative approaches used for data analysis. Concept Maps can be used to construct experiences individually and in groups in data collection and analysis in qualitative research. Concepts maps can be used to collect, reduce, organize, and interpret data. Concept maps graphically demonstrated the concepts and connections in areas such as critical thinking and online learning. Jackson and Trochim (2002) write about the use of concept maps as an alternative approach for the examination of open-ended survey responses. It gives a snapshot of perception and allow for the refining additional data collection processes concept mapping is a way to develop logical thinking and study skills; it reveals how concepts are connected. Students not only see connections, but are also able to visualize how larger concepts are broken down into simpler ones. A key feature of concept maps is that they are constructed to represent text structure patterns which serve to help students' mental constructs or schemata of how texts are organized. By mapping ideas into maps designed to model text structure patterns, teachers help students to visualize relationships and learn patterns (Bos & Anderson, 1990 cited in Guastello, Beasley, and Sinatra, 2000). Bunting, Coll, and Campbell (2006) observed that students who attended tutorial using concept mapping achieved significantly higher marks than those who attended a convectional tutorial or no tutorial. The study aims to investigate how concept mapping influences students' academic achievement. Specifically, it examines whether using concept maps enhances understanding, retention, and overall performance compared to traditional teaching methods. The objectives include assessing students' perceptions of concept mapping, measuring its impact on academic performance, and providing recommendations for integrating concept mapping into classroom teaching. This study is significant because it offers insights into effective teaching strategies that improve learning outcomes. For students, it highlights how concept mapping can enhance comprehension and retention. For teachers, it provides an interactive tool to facilitate learning. The findings can guide curriculum developers and educational institutions in adopting visual learning methods, ultimately contributing to higher academic achievement and improved educational quality.

METHODOLOGY

The methodology section follows with a detailed explanation of the data extraction process, and the models that are employed in the study.

Data

The data for this study were collected from a total population of 400 students, out of which a sample of 200 participants was selected using a stratified random sampling technique to ensure fair representation of both genders and different education levels. A structured questionnaire was used as the primary data collection tool, consisting of Likert-scale items designed to measure students' perceptions of concept mapping in learning. The questionnaire covered key areas such as understanding difficult topics, improving memory, making learning more interesting, and enhancing academic performance. Before data collection, participants were informed about the purpose of the study and assured of confidentiality to encourage honest responses. The survey was administered in person within classroom settings, allowing respondents to complete it under supervision. The collected data were then coded and analyzed using SPSS software, employing descriptive statistics, correlation analysis, and t-tests to evaluate relationships among variables and assess the overall impact of concept mapping on students' learning outcomes.

Descriptive Statistics

Descriptive statistics are statistical methods used to summarize, organize, and present data in a meaningful way, often through measures such as mean, median, standard deviation, frequencies, and percentages, which provide a clear overview of the characteristics of a dataset (Gravetter & Wallnau, 2017).

Correlation

Correlation is a statistical technique used to measure the strength and direction of the relationship between two or more variables. It indicates how one variable changes in relation to another, without implying a cause-and-effect relationship. The correlation coefficient, often denoted as r, ranges from -1 to +1, where a positive value shows that both variables move in the same direction, a negative value indicates they move in opposite directions, and a value near zero suggests no relationship (Cohen, 1988). It is an essential tool in quantitative research for identifying patterns, associations, and trends between variables (Field, 2013).

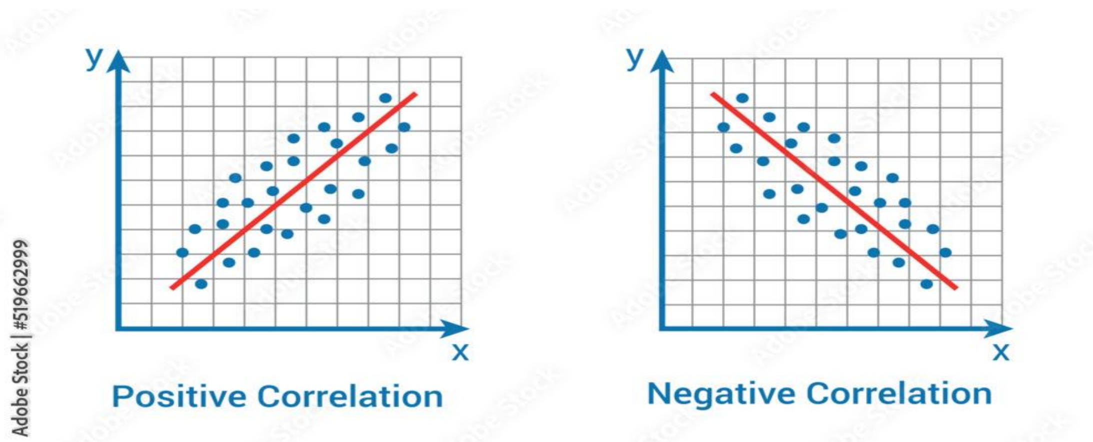

Figure 1:

Analysis of Variance

ANOVA, which stands for Analysis of Variance, is a statistical technique used to determine whether there are any significant differences between the means of three or more groups. It compares the variation between group means to the variation within groups to see if at least one group differs significantly from the others (Field, 2013). The main idea is that if the between-group variance is much larger than the within-group variance, it suggests that the independent variable has a real effect on the dependent variable. ANOVA produces an F-statistic, and if its associated p-value is less than the significance level (commonly 0.05), the result is considered statistically significant. However, while ANOVA tells us that differences exist, it does not specify which groups differ—for that, post hoc tests are used (Gravetter & Wallnau, 2017).

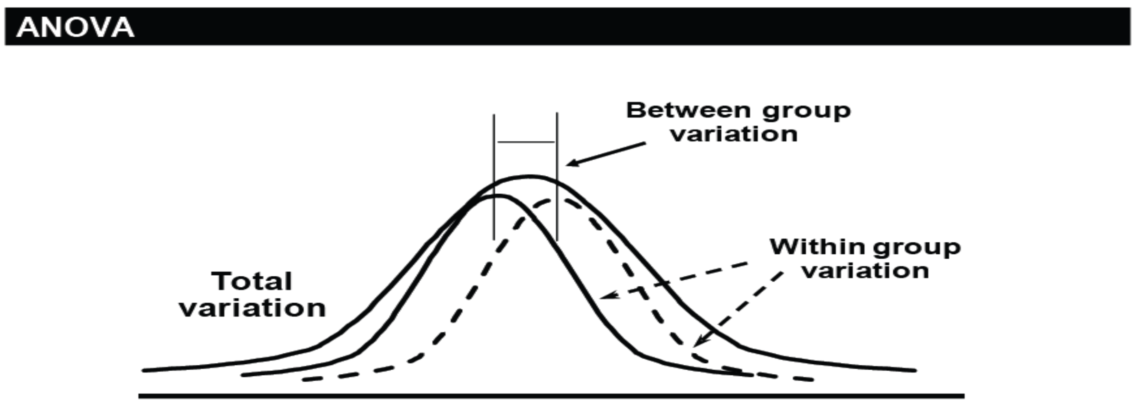

Figure 2:

RESULT AND DISCUSSION

This chapter consists of results and discussion after applying various statistical tools for data analysis in order to achieve all the objectives. Descriptive statistics and histograms were used to summarize and visualize the data, highlighting key patterns, distributions, and potential outliers. Correlation analysis and heatmaps were applied to examine relationships between variables, providing a visual representation of their associations. Furthermore, ANOVA was conducted to assess differences between groups and determine the statistical significance of these differences. This combined approach provided a clear understanding of the data patterns, relationships, and group differences.

Table 1: Descriptive statistics

Variable	N	Min	Max	Mean	Std. Deviation	Skewness	Kurtosis
Gender	200	1	2	1.415	0.494	0.244	-1.898
Age	200	1	4	2.120	1.020	1.041	-0.833
Education Level	200	1	4	2.510	0.839	0.703	-0.573

The descriptive statistics of the sample (N = 200) show that the majority of participants were slightly more female than male, as indicated by the mean gender value of 1.415 on a 1–2 scale. The average age of respondents was 2.12 on a 1–4 scale, suggesting that most participants belonged to the younger age groups. The education level had a mean of 2.51, indicating that students were mostly at intermediate or undergraduate levels. The standard deviations indicate moderate variability in age and education, while skewness and kurtosis values show that the distributions are slightly skewed but not extremely non-normal. Overall, these results reflect a diverse but relatively balanced sample in terms of gender, age, and education.

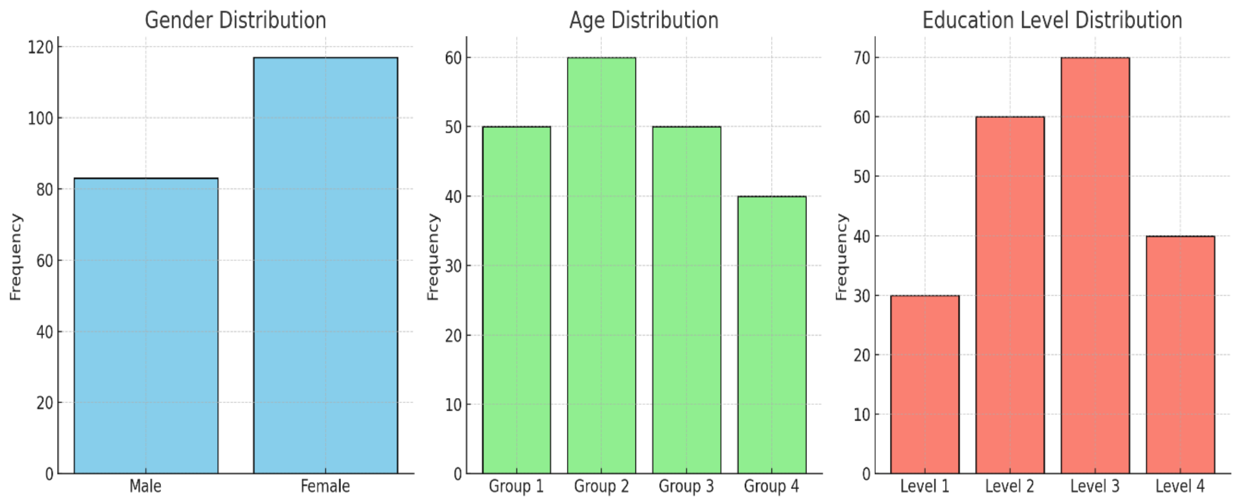

Figure 3: Histogram gender, age, education

Table 2: Correlation

Variables	r	P
Gender & Learning more interesting	0.18	0.011
Gender & Academic performance	0.29	0.000
Gender & Teachers explain clearly	0.19	0.006
Age & Education level	0.15	0.040
Age & Use in all subjects	-0.14	0.042
Education & Understand difficult topics	-0.19	0.007
Education & Teachers explain clearly	0.19	0.007
Education & Use in all subjects	-0.21	0.002
Understand difficult topics & Learning more interesting	0.27	0.000
Remember concepts & Prefer concept mapping	0.21	0.003
Prefer concept mapping & Academic performance	0.27	0.000
Teachers explain clearly & Connect new info	0.20	0.006

The correlation analysis reveals several significant relationships among the studied variables. Gender showed positive correlations with finding learning more interesting ($r = 0.18$, $p = 0.011$), improved academic performance ($r = 0.29$, $p = 0.000$), and clearer teaching through concept maps ($r = 0.19$, $p = 0.006$), indicating that perceptions about concept mapping differ slightly by gender. Age was positively correlated with education level ($r = 0.15$, $p = 0.040$) but negatively correlated with the desire to use concept maps in all subjects ($r = -0.14$, $p = 0.042$), suggesting that older participants were less inclined to apply concept mapping broadly. Education level had a negative correlation with understanding difficult topics ($r = -0.19$, $p = 0.007$) and using concept maps in all subjects ($r = -0.21$, $p = 0.002$), but a positive correlation with teachers explaining more clearly ($r = 0.19$, $p = 0.007$), implying that higher-educated participants were more critical yet appreciated clarity in instruction. Strong positive associations were also observed between understanding difficult topics and finding learning more interesting ($r = 0.27$, $p = 0.000$), remembering concepts and preferring concept mapping ($r = 0.21$, $p = 0.003$), preferring concept mapping and improved academic performance (r = 0.27, p = 0.000), and teachers explaining clearly and helping students connect new information (r = 0.20, p = 0.006). Overall, these results suggest that positive attitudes toward concept mapping are interconnected, enhancing both understanding and academic engagement.

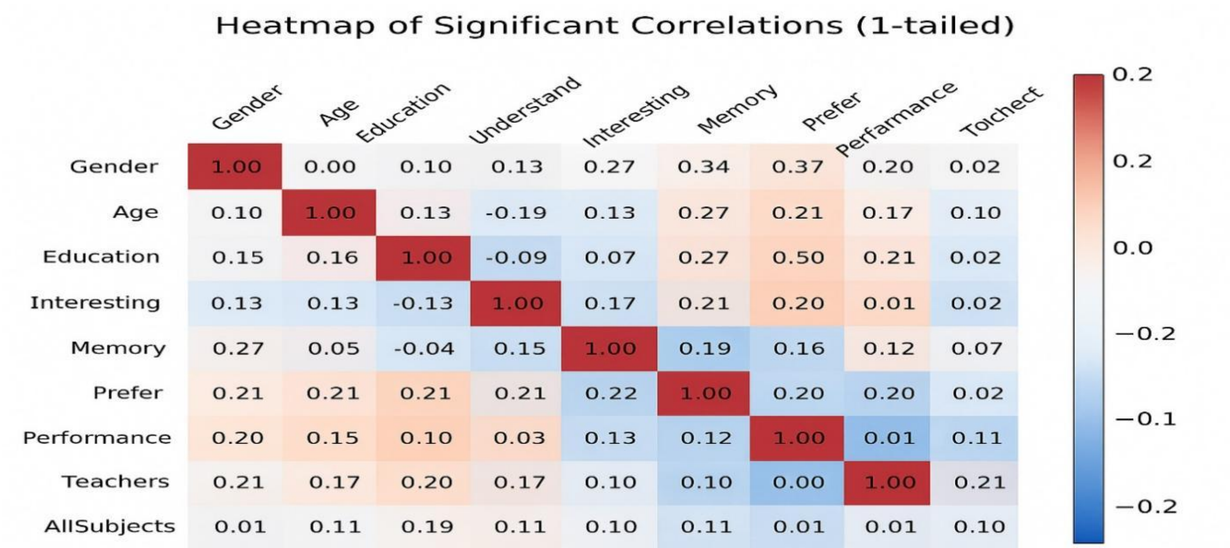

Figure 4: Heat map correlation

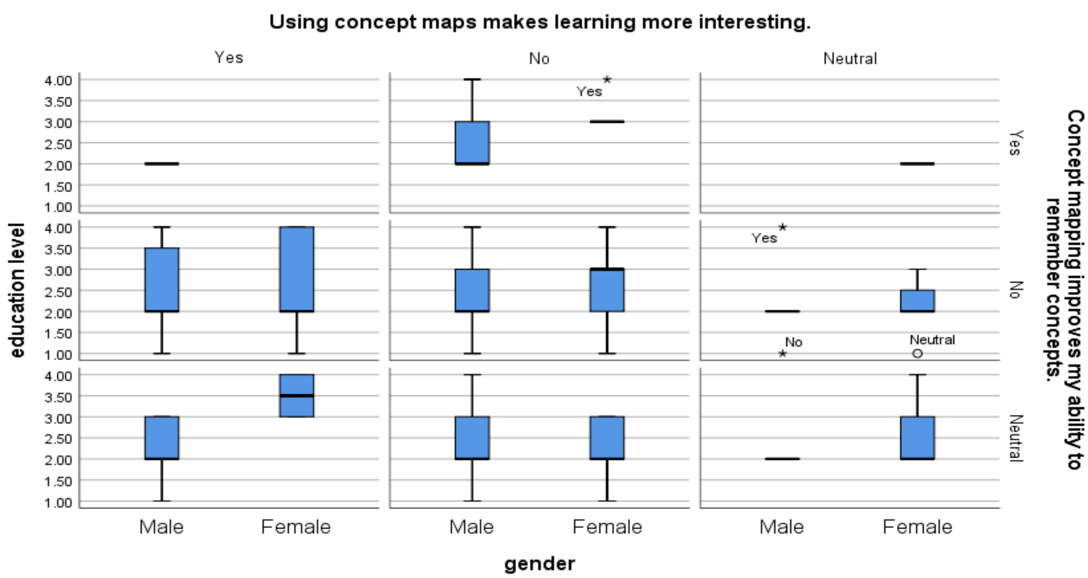

Table 3: Analysis of variance

Source	SS	df	MS	F	Sig.	Bayes Factor
Between Groups	3.752	3	1.251	4.140	0.007	0.220
Within Groups	59.213	196	0.302	—	—	—
Total	62.965	199	—	—	—	—

The ANOVA table shows the comparison of variability between and within groups to determine if there are statistically significant differences among the group means. The between-groups sum of squares (SS = 3.752) with 3 degrees of freedom (df) and a mean square (MS = 1.251) indicates the variation due to differences among the group means. The within-groups sum of squares (SS = 59.213) with 196 degrees of freedom and MS = 0.302 represents the variation among individuals within each group. The F-value (4.140) is the ratio of the between-group variance to the within-group variance, and its significance level (p = 0.007) is below 0.05, meaning the difference among group means is statistically significant. This suggests that the independent variable had a significant effect on the dependent variable. The Bayes Factor (0.220) provides moderate support for the alternative hypothesis, reinforcing that real differences exist among the groups rather than occurring by chance.

CONCLUSION

The study demonstrates that concept mapping significantly enhances students' academic achievement by promoting meaningful learning, improving retention, and encouraging active engagement. Students who utilized concept maps showed better comprehension of complex topics and higher overall performance compared to those relying solely on traditional methods. Positive correlations between preference for concept mapping, understanding difficult topics, and improved academic outcomes indicate that this tool not only supports cognitive development but also increases motivation and interest in learning. Concept mapping serves as a valuable teaching and assessment strategy, allowing educators to identify knowledge gaps, provide clearer explanations, and evaluate students' conceptual understanding effectively. Incorporating concept mapping into classroom instruction can therefore foster higher-order thinking skills, support collaborative learning, and contribute to improved educational quality across various disciplines.

REFERENCES

Adey, P., & Shayer, M. (1994). Really raising standards. London: Routledge.

Amundson, N. E. (2003). Active engagement: Enhancing the career counselling process (2nd ed.). Richmond, BC, Canada: Ergon Communications.

Amemado, D. (2014). Integrating technologies in higher education: the issue of recommended educational features still making headline news. Open Learning: The Journal of Open, distance and e-Learning, 29(1), 15-30.

Ariagai, B. A., & Nwanekeziii, A. U. (2018). Concept Mapping Strategy and its Effects on Students' performance in Senior Secondary School Organic Chemistry in Imo State of Nigeria. International Journal of Scientific Research in Education, 11(4), 797-809.

Ausubel, DP, & Barberán, S. (2002). Knowledge acquisition and retention a cognitive perspective (No. 370.15 A9).

Ausubel, D. P. (1963). The psychology of meaningful verbal learning. New York, Grune and Stratton.

Ausubel D (1968). Educational psychology: A cognitive view. New York: Holt Rinehart and Winston.

Ausubel, D. P., Novak, J. D., & Hanesian, H. (1968). Educational psychology: A cognitive view (Vol. 6). New York: holt, Rineart and Winston.

Baylen, D. M., Duckett, E., & Arellano, E. (2017). Concept Mapping as Note-Taking Strategy in University Science Courses. International Journal, 11(2), 22-28

BouJaoude S, Attieh M (2008). The Effect of Using Concept Maps as Study Tools on Achievement in Chemistry. Eurasia J. Math. Sci. Technol. Edu. 4(3): 233-246.Brott, P. (2005). A constructivist looks at life roles. Career Development Quarterly, 54(2),

Cañas AJ, Novak JD (2005). The Theory Underlying Concept Maps and How to Construct and Use Them, Technical Report IHMC CmapTools Florida Institute for Human and Machine Cognition.

Chiou, C. C., Lee, L. T., Tien, L. C., & Wang, Y. M. (2017). Analyzing the effects of various concept mapping techniques on learning achievement under different learning styles. EURASIA Journal of Mathematics, Science and Technology Education.

Conole, G., Dyke, M., Oliver, M., & Seale, J. (2004). Mapping pedagogy and tools for effective learning design. Computers and Education, 43, 17–33. Doi: 10.1016/j.compedu.2003.12.018.

Daley, B. J., & Cervero, R. M. (2014). Continuing professional education, development and learning. In R. Poell, T. Rocco, & G. Roth, G. (Eds.), The Routledge companion to human resource development (pp. 40–49). London, UK: Routledge.

Danmole, B. T.& Ade Ayo, S.A (2004). Effect of concept mapping on students' academic performance in junior secondary school integrated Science in llorin metropolis. Journal of curriculum and instruction

Duffy, T., & Jonassen, D. (1992). Constructivism: New implications for instructional technology. In T. Duffy & D. H. Jonassen (Eds.), Constructivism and the Technology of Instruction (pp. 1–16). Hillsdale, New Jersey: Lawrence Erlbaum.

Enger, S. K. (Nov, 1998). Students' conceptual understanding: qualitative evidence in concept maps. In: Paper presented at the Annual meeting of the mid-South Education Research association (27th New Orleans CA).

Gabel D (1999). Improving teaching and learning through chemistry education research: A look to the future. J. Chem. Edu. 76: 548-554.

Govt. Of Pakistan. (2006). National curriculum for General Science, grade IV- VIII. Islamabad; Ministry of Education.

Hafeez, M. (2021). Assessment of academic achievements and memorization power of students by concept map strategy and traditional lecture approach. International Journal of learning and Teaching, 13(3), 133-145.