EFFECT OF CONCEPT MAPPING APPROACH ON SCIENTIFIC ATTITUDE AND ACHIEVEMENT IN SCIENCE AMONG STUDENTS WITH LEARNING DISABILITY

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Students with learning disability must be equipped with means to develop their metacognitive capacities especially the 'learning to learn' skills for effective lifelong learning. Concept mapping is one such strategy and this study aims to determine the effectiveness of this approach on scientific attitude and achievement in science among students with learning disability. A two group, pre-test or post-test, quasi-experimental design was employed, where 35 students with learning disability of Class VIII studying in Govt. schools of Chandigarh were selected and randomly assigned to control and experimental groups. The control group (18 students, 10 Boys + 8 Girls) received conventional teaching whereas the experimental group (17 students, 8 Boys + 9 Girls) received teaching via Concept Mapping Approach for a period of 20 days. Their scores were measured on SAS-KAGS by Kaur and Gakhar and SAT by the researcher herself. Analysis of pre- and post-test data revealed that the Concept Mapping Approach is more effective in improving achievement in science, scientific attitude as well as retention of learned knowledge among students with learning disability as compared to conventional teaching method.

Keywords: Concept Mapping, Scientific Attitude, Achievement in Science and Learning Disability

Introduction

An extensive range of scientific concepts, held at the core of science curriculum, helps to identify science as a conceptual subject. These concepts of science are also related to concepts and sub-concepts in other subjects and our daily life too. Hence, poor performance in science subject may be connected to poor grades overall, this is why science education is given immense importance in school education. Teaching of science emphasises on inculcating a scientific attitude and arousing interest in science among the learners (Dani, 1989). The National Education Policy (NEP 2020) also stresses that science curriculum must incorporate scientific methods in order to develop scientific attitude among students to encourage meaningful learning instead of rote learning. Fostering scientific attitude among students further encourages achievement in science. In fact, many researches have proven the relationship between achievement in science and scientific attitude (Bettaswamy, 2012; Olasehinde and Olatoye, 2014; Singh, Singh and Giri, 2016; Ahuja, 2017).

Meaningful science education is seen as a vehicle for training the child to think logically, reason and analyse systematically, nurture the natural curiosity and to cultivate objectivity and scientific attitude in the students (Panditrao and Panditrao, 2020). Nurturing scientific attitude helps in developing scientific mind which in turn is essential for achievement in science. But sadly, we

have failed in achieving the aims of science education proposed by our education policies. This is evident from previous educational surveys such as the Hoshangabad Science Teaching Programme's (1972–2002) 30 year review. The report mentioned that science education in the country paints a dismal picture as there is mainly emphasis on textbook-based rote learning with no scope for experimentation and exploration (Mukund, 1988). Also a similar scenario is noticeable in recent educational surveys such as the National Achievement Survey (NAS) 2021, report showing that the overall average performance of the students in science at primary, elementary, as well as secondary level, is the lowest among all other subjects with a score of 228 (in scaled scores out of 500). This lag in achievement in science can be attributed to factors related to students such as lack of scientific attitude, motivation, etc., or even presence of invisible disabilities like learning disability.

Specific Learning Disability (SLD) is a developmental disorder, manifesting as difficulty in reading, writing, comprehending or using language, calculations, wherein the child has normal intelligence and conventional schooling, adequate motivation and opportunity, and intact hearing and visual capacity (Singh *et al.,* 2017). Around 5–15 per cent of school going children have this disability (Karande, Bhosrekar, Kulkarni and Thakker, 2009), out of which dyslexia is the most common, followed by dysgraphia and dyscalculia. Science is a part of the curriculum that can be particularly challenging to students with learning disability because of the diverse demands it places on cognitive performance (Brigham, Scruggs, and Mastropieri, 2011). Researchers revealed that children with special needs tend to show magnificently lower achievement in science than their peer groups (Steele, 2007; Bell and Bell, 2002; Scruggs, Mastropieri and Boon, 1998).

Continuing use of poor teaching methods is one of the major cause of low level performance in science subject (Tandog and Bucayong, 2019). Hence, science teachers must be equipped with scientific teaching-learning strategies to involve the different intelligences and explore the maximum potential of students in an inclusive setup. Concept mapping strategy is one such metacognitive tool which helps to inculcate high order thinking and learning skills in the students, which in turn promotes development of scientific temperament and sound intellect. It presents knowledge in a systematic and hierarchical manner which specially helps the students with learning disability as they are more comfortable when information follows some structured pattern. Also, concept maps helps to reduce the cognitive load by removing the clutter of conventional textbooks and notes (Hwang, Kuo, Chen and Ho, 2014). Thus this tool can be of immense value for the students with learning disabilities helping them to construct causal-effect connections between concepts and to think about their own thinking or if put in the words of Novak, 'learning how to learn' (Novak and Gowin, 1984). Concept maps act as a learning tool which facilitates the organisation and retrieval of information with a graphic alternative to the written text. They enhance cognitive abilities even in the presence of learning disorders (Oliva and Antonietta, 2012).

Concept maps were first developed in 1972 by Joseph Novak and have since been utilised by special educators and curriculum designers

around the world as they act as a blueprint to maximise the learning environment through multiple representations of concepts (Kachhap, Devi and Mane, 2021). Although this strategy has been studied by Indian researchers under mainstream education domain like (Thomas and Thakur, 2011; Cheema and Mirza, 2013; Aziz and Rahman, 2014; Chawla and Singh, 2015; Marutirau and Patankar, 2016; Kumar and Singh, 2017; Hazare, 2018) as well as in special education like visual disability (Kachhap and Mane, 2019), diverse learning needs (Kachhap, Devi and Mane, 2021) and children with disabilities (Madan and Sharma, 2013). Its potential is not fully tapped in the area of students with learning disability in Indian scenario. Hence, the researcher got motivated to study the use of concept mapping in developing scientific attitude and improving achievement in science among students with learning disability.

Review of Related Literature

Concept Mapping and Learning Disability

Studies show that concept mapping strategy can help improve reading performance of students with reading difficulties (Undalok and Salbabro, 2022) and expository text comprehension in students with learning disability (Hendi, 2015; Calvin, 2022) as well as in poor readers (Morfidi, Mikropoulos, and Rogdaki, 2018). It helps in achieving accurate acquisition of science content among the students with learning disability by making use of computer-based concept maps (Ciullo, Falcomata and Vaughn, 2015) or concept maps based evaluation sheets (Vlachos and Zamfirov, 2017) and better acquisition of factual knowledge (Sperling, Grünke and Cöppicus, 2019).

Concept Mapping and Achievement in Science:

Studies reveal that concept mapping helps in improving achievement as well as retention in subject areas that are closely related to the natural or exact sciences such as physics (Agube, Ntibi and Neji, 2021); social studies (Singh and Bajwa, 2017); genetics (John, Sani, Ranccas and Maskawa, 2019); science (Hazare, 2018; Aziz and Rahman, 2014; Thomas and Thakur, 2011); chemistry (Jack, 2013) and biology (Marutirao and Patankar, 2016). Some other studies confirmed the positive effect of concept maps on achievement among low performance cases (Kumar and Singh, 2017) and even low achievement motivation cases (Chawla and Singh, 2015).

Thus, it can be inferred that concept mapping strategy can be utilised to cater to the heterogeneity presented by the diverse group of learners especially the ones presenting with learning disabilities across all the science subjects including biology, physics or genetics, etc. Also, the strategy has varied applications covering different areas of education including teaching, learning and retention of knowledge as well as for evaluation.

Justification of the Problem

Teaching via concept mapping strategy enhances meta-cognitive skills among students and help to reduce the cognitive load on students which can be extremely helpful for students with learning disabilities as they gain immensely when knowledge is self-constructed by them. This is especially true if the information is created independently under the supervision of a special educator.

Concept maps constructed by the students with learning disability should be able to provide them with a valuable tool in science learning by removing the clutter of conventional textbooks as science is a conceptual subject. Hence, it has been used extensively in research works for special education across the world but the same cannot be said about the studies in Indian context where its potential is not tapped completely. Although, this approach has been used nationwide in the area of mainstream education, and some in other disability areas such as children with visual disability (Kachhap and Mane, 2019), diverse learning needs (Kachhap, Devi and Mane, 2021) and children with disabilities (Madan and Sharma, 2013), there is a dearth of researches where this strategy has been used for students with learning disability. Hence, the proposed study appears to be fully justified in assessing the effect of concept mapping approach on scientific attitude and achievement in science among students with learning disability.

Objectives

1. To compare the effect of Concept Mapping Approach and Conventional Teaching Method on Scientific Attitude of VIII standard students with Learning Disability
2. To compare the effect of Concept Mapping Approach and Conventional Teaching Method on achievement in Science of VIII standard students with Learning Disability
3. To compare the effect of Concept Mapping Approach and Conventional Teaching Method on retention of achievement in science of Class VIII students with Learning Disability

Hypotheses

1. There will be no significant difference in the effect of Concept Mapping Approach and Conventional Teaching Method on Scientific Attitude of VIII standard students with Learning Disability.
2. There will be no significant difference in the effect of Concept Mapping Approach and Conventional Teaching Method on achievement in Science of VIII standard students with Learning Disability.
3. There will be no significant difference in the effect of Concept Mapping Approach and Conventional Teaching Method on retention of achievement in science among VIII standard students with Learning Disability.

Tools of the Study

Two tools were used for the present study, namely

A) Scientific Attitude Scale (SAS-KAGS)

By Kaur and Gakhar (2004, 2014): A standardised tool to measure the scientific attitude of the students.

B) Science Achievement Test (SAT)

Constructed by the researcher herself to measure the achievement in science among the students. A preliminary draft of SAT consisting of 240 items was constructed in accordance with the blue print framed after considering the weightage for content, objectives and difficulty level. This draft was tried out for item analysis in which only 120 items having difficulty value in the range of 20–80 per cent, and discrimination

index ranging from 0.3 to 0.6 were selected for the final SAT.

Validity of SAT was established by a panel of experts consisting of pedagogy experts, CWSN in charge as well as the resource teachers who took active participation in the decisions regarding the objectives of the test, distribution of weightage given to objectives and content areas. Their suggestions were incorporated and thus, content validity was established for SAT.

Reliability of SAT was established by test-retest method. The final SAT was administered twice on 60 students of Class IX within a gap of 20 days. The scores of test retest method were tested by applying Pearson Correlation. The 'r' value came out to be 0.75 (N = 240) which was significant at 0.01 level of significance.

Variables of the Present Study

There were two teaching strategies used in the present study, i.e., teaching via conventional teaching strategy and teaching via concept mapping strategy which serve as the independent variables in this study, whereas Scientific Attitude Scores and Achievement in Science were the two dependent variables. The mean gain scores for the dependent variables on the Science Achievement Test (SAT) and Scientific Attitude Scale (SAS), were used to evaluate the effectiveness of the two teaching strategies.

Control

To keep the 'noise' in the data to a minimum, control was exercised for extraneous variables by holding them constant for both the groups, such as, age (14–16 years), Class VIII, Disability (Learning Disability), Testing and learning environment (Govt. schools), subject and topics covered (5 units of science), duration of intervention (20 days) as well as the objectives of intervention were same for both the groups. Also the instructor, evaluator and examiner bias were reduced as the researcher herself played all the roles. In order to counteract the impact of pre-existing subject knowledge, the evaluation was conducted on the gain scores.

Method and Procedure

For the present study a two group, pre-test or post-test, Quasi-experimental, explanatory research design was adopted. The study was conducted in six phases explained below:

Phase I (Construction of Lesson Plans)

For Experimental Group

Lesson plans with concept maps were constructed following the rules laid down by Joseph Novak himself (Novak and Cañas, 2009). A total of 5 units were chosen as content for instructions, which were further divided into 10 topics (2 from each unit) for maximum coverage. Hence, a total of 10 lesson plans with concept maps were constructed, revised and referred to the panel of experts for content validation.

For Control Group

Keeping the content of instructions same, 10 lesson plans without concept maps were constructed by following Herbartian approach which were again revised and referred to the panel of experts for long with an opinionnaire for content validation.

Phase II (Sampling)

The inclusion criteria for sampling was set forth and only those Government schools in Chandigarh were included in the study

where there were 5 or more students with learning disabilities enrolled in Class VIII for the academic session 2022–23. The details of Government schools in Chandigarh were obtained from the Assistant Project Coordinator, Inclusive Education SSA, U.T. Chandigarh. There were only 6 such Government Schools who fulfilled the inclusion criteria as other schools had less than 5 students with Learning Disability enrolled in Class VIII. So the final sample consisted of 35 students (18 Boys + 17 Girls) which were then randomly grouped into Experimental (N = 17, 8 Boys + 9 Girls) and Control Groups (N = 18, 10 Boys + 8 Girls).

Phase III (Pre-test Phase)

The SAT and SAS were administered to both the groups in order to procure baseline measurements for their level of scientific attitude and achievement in science with the help of pre-test scores.

Phase IV (Intervention Phase)

Orientation was given to both the groups before stating intervention, which was different for each group.

Experimental Group

Students were introduced to the concept of concept mapping, its advantages as well as the construction process by help of some simple concept maps in the orientation phase. Students were provided with the materials required to draw maps by the researcher. Thereafter lectures were conducted where the students made concept maps of all the topics under the guidance of the researcher who explained the concepts, links and the overall structure of the map to the students. The content of the lectures was recapitulated at the end of every lecture.

Control Group

Lectures were conducted for the students using the lesson plans constructed with the help of Herbartian Approach by the researcher herself. NCERT Science Textbook for Class VIII was used to read and explain all the topics, although the students were given the same recapitulation exercises at the end of every lecture as the other group.

Thus a total of 450 minutes or 7.5 hours of instructions were delivered to each group at the rate of 45 minutes for each lesson plan.

Phase V (Post-test I Phase)

Measurements (post-test I scores) were taken immediately after the intervention phase and the mean gain scores of the two dependent variables, served as a numerical index employed to compare the success rates of two teaching methods.

Phase VI (Post-test II Phase)

In the last phase of the study, the students were again tested for achievement in science scores (post-test II scores) after a gap of six weeks to measure their information retention.

Results and Discussion

Statistical tests were applied to both pre-test data as well as post-test data

(A) Pre-test data

The two groups were tested with the help of independent t-test to establish their equivalence in terms of level of scientific attitude and science achievement scores of students before the intervention. The results are depicted in Table 1.

Table 1 reveals that mean scores and standard deviation of the Control and Experimental group for Scientific Attitude

before intervention were 178.94, 4.929 and 179.29, 5.133 respectively. The t-value came out to be 0.206 which is non-significant (p→0.05). Also the mean scores and standard deviation of the control and experimental group for science achievement before intervention were 63.94, 6.476 and 63.94, 6.759, respectively. The t-value came out to be 0.001 which is non-significant (p→0.05).

Interpretation: Thus, before the intervention, both the groups were equivalent with respect to level of scientific attitude of students as well as achievement in science.

Table 1: Matching the Groups on the Basis of Pre-test Scores

Variable	Group	N	Mean	SD	t-value	p-value
Scientific Attitude	Control	18	178.94	4.929	0.206 (N.S.)	0.838
	Experimental	17	179.29	5.133		
Science Achievement	Control	18	63.94	6.476	0.001 (N.S.)	0.999
	Experimental	17	63.94	6.759		

N.S. Means Non-significant (Value of t-ratio Significant at 0.05 Level = ...)

(B) Post-test data

(i) Hypothesis 1: There will be no significant difference in the effect of Concept mapping Approach and Conventional Teaching Method on Scientific Attitude of Class VIII students with Learning Disability.

To test this hypothesis, paired t-test was utilised on the mean gain scores of scientific attitude attained by the students of Experimental and Control groups. The results are shown in Table 2.

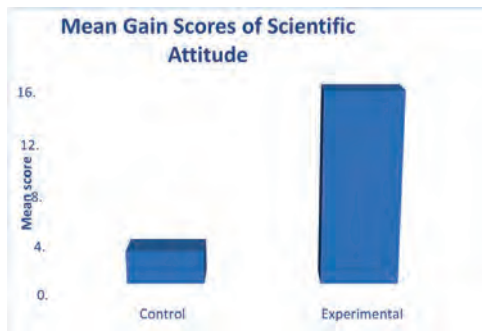

Fig. 1. Graphical representation of the Mean Gain Scores of Students in Scientific Attitude for Control and Experimental Group

Table 2 and Fig. 1 reveal that the mean gain scores of students in scientific attitude for control and experimental groups comes out to be 2.78 and 15.71 respectively and the t-value is 30.823 which is significant at 0.01 level of significance. This implies that there exists

Table 2: Comparison of the Two Groups for Mean Gain Scores in Level of Scientific Attitude

Variable	Group	N	Mean Gain	SD	t-value	p-value
Scientific Attitude	Control	18	2.78	1.59	30.823	0.000**
	Experimental	17	15.71	0.77		

a statistically significant difference among the two approaches in improving scientific attitude among student with learning disability. Thus, hypothesis 1 stands rejected.

Interpretation: This implies that the concept mapping approach is better than the conventional teaching method in improving the scientific attitude of students with learning disability.

(ii) Hypothesis 2: There will be no significant difference in the effect of Concept mapping Approach and Conventional Teaching Method on Achievement in Science of Class VIII students with Learning Disability.

To test this hypothesis, paired t-test was utilised on the mean gain scores of Achievement in Science attained by the students of Experimental and Control groups. The results are shown below in Table 3.

*'p'-value significant at 0.01 level

Table 3 and Fig. 2 reveals that the mean values of gain score of achievement in science for control and experimental groups are 10.67 and 21.18. The reported t-value is 7.788 which is significant at 0.001 level. This implies that there exists a statistically significant difference among the two approaches in improving Achievement in Science among student with learning disability. Thus, hypothesis 2 stands rejected.

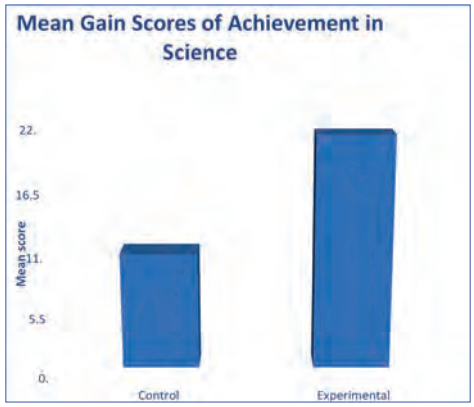

Fig. 2. Graphical representation of the Mean Gain Scores of Students in Achievement in Science for Control and Experimental Group

Interpretation: This implies that concept mapping approach is better than the conventional teaching method in improving the achievement in science of students with learning disability.

(iii) Hypothesis 3: There will be no significant difference in the effect of Concept mapping Approach and Conventional Teaching Method on retention of achievement in science among Class VIII students with Learning Disability.

To test this hypothesis the mean gain scores (retention) were calculated by deducting the pre-test scores of achievement in science from the post-test II scores (delayed post test scores) for all the students. These scores

Table 3: Comparison of the Two Groups for Mean Gain Scores in Achievement in Science

Variable	Group	N	Mean Gain	SD	t-value	p-value
Achievement in Science	Control	18	10.67	4.19	7.788	0.000**
	Experimental	17	21.18	3.80		

then underwent paired t test in order to find the significance of difference between the two groups. The values are as shown in Table 4.

Table 4 and Fig. 3 reveal that the mean scores of students on retention of learned information for control and experimental groups comes out to be 6.44 and 19.59 respectively and the t-value is 9.11 which is

Table 4: Comparison of the Two Groups for Mean Gain (Retention) Scores of Students

Groups	N	Mean gain (Retention)	SD	t-value	p-value
Control	18	6.44	3.99	9.110	.000*
Experimental	17	19.59	4.54		

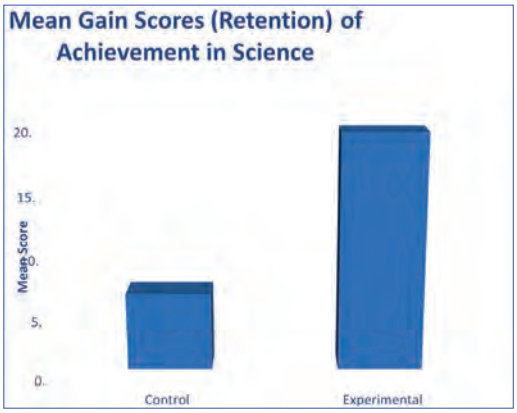

Fig. 3. Graphical Representation of Mean Gain Scores (retention) of Students on Achievement in Science for Control and Experimental Group

significant at 0.01 level of significance. This implies that there was statistically significant difference in the effect of both the approaches on retention of learned knowledge. Thus, Hypothesis 3 stands rejected.

Interpretation: This implies that concept mapping approach is better than the conventional teaching method in terms of retention of learned information among students with learning disability.

Discussion

The purpose of this study was to compare the effectiveness of the conventional teaching methods against the concept mapping approach for teaching science to students with learning disabilities. On analysing the data collected pre- and post-test, it was found out that the students in the experimental group (concept mapping) have gained significantly higher scientific attitude scores than those who were in the control group (conventional teaching). This finding is analogous with formerly done study conducted in 2018 by Jatmiko *et al.* where they found an improvement in students' scientific attitudes through the 'Reading-Concept Map Think Pair Share' model. The study was conducted to junior high school students by employing Quasi-experimental research design. Another study carried out in West Bengal, India by Bera and Mohalik in 2016, to study effectiveness of concept mapping strategy on cognitive processes in science at secondary level also supported this finding. They even recommended that concept mapping should be used in science teaching for the development of student's higher order thinking level.

A similar analysis was drawn out of the post-test data for achievement in science among the students. It showed that students who were taught via concept mapping strategy have gained significantly higher scores in the

Science Achievement Test (SAT) than those students who were taught via conventional teaching method. This finding syncs with the conclusions made by Thomas and Thakur in 2011, where they found out that concept mapping has a noticeable impact on Class VIII student achievement in science education. Another study done on Class VII students revealed similar conclusions (Cheema and Mirza, 2013).

On analysing the post-test II scores of achievement in science for both the groups it was learned that again the students in the experimental group were remarkably better than the control group. Singh and Bajwa (2017) reported similar findings when they used concept mapping strategy on Class IX students for the subject of social studies, in relation to their intelligence and study habits. The experimental study was conducted on 80 students of Class IX. The pre- and post-intervention scores were analysed to conclude that concept mapping strategy were significantly superior to traditional method in teaching retention of social studies. Likewise a pre-test, post-test, non-equivalent control groups quasi-experimental research done by Agube, Ntibi and Neji (2021), showed similar results for achievement in physics. They concluded that that the adoption of concept mapping strategy in teaching and learning aid retention knowledge.

Conclusion

Thus, it can be concluded that teaching via concept mapping approach is more effective in enhancing achievement in science as well as scientific attitude among students with learning disability as compared to conventional teaching method.

In other terms, it can be said that those students with learning disability who received teaching instructions via concept mapping approach gained significantly more than those students with learning disability who were taught via traditional method of teaching in terms of scientific attitude, achievement in science as well as retaining the learned information. Consequently, the efficacy of the concept mapping approach in teaching science to students with learning disability can be determined (Aziz and Rahman, 2014; Chawla and Singh, 2015; Marutirau and Patankar, 2016). Also supporting evidence is found claiming improvement in scientific attitude with the use of concept mapping approach for teaching (Jatmiko *et al.,* 2018; Khan, Shah, Mahmood, and Zareen, 2012; Agnafia, Anfa and Rizkia, 2022). Concept mapping approach leads to more meaningful learning of difficult concepts and hence enhances retention (Jack, 2013), also construction of maps helps the students to retain more knowledge as they are in control of their thought process involved in connecting the working memory with the long term memory as new knowledge is being received (Anderson, 1992).

Educational Implications of the Study

Results of the present study supported that students with learning disability can benefit tremendously from the concept mapping approach as it helps in reduces the burden of language by reducing wordiness and organising the content to be learned in a pattern following a hierarchical structure. Also incorporating concept maps in classroom settings encourage critical thinking and development of scientific attitude among students with learning disability. Hence, this approach is strongly recommended for teaching science to students with learning disability.

References

Agnafia, D. N., Q. Anfa and A. Rizkia. 2022. Improvement of Science Attitude Through Scientific Approach in Environmental Science Courses. *Journal of Biology Learning.* Vol. 4, No. 1. pp. 156–164.

Agube, C. C., J. E. E. Ntibi and H. A. Neji. 2021. Towards Enhancing Physics Students' Academic Achievement through Concept Mapping Instructional Strategy. *European Journal of Social Sciences.* Vol. 61, No. 4. pp. 250–259.

Ahuja, A. 2017. Study of Scientific Attitude in Relation to Science Achievement Scores Among Secondary School Students. *Educational Quest—An International Journal of Education and Applied Social Sciences.* Vol. 8, No. 1. pp. 9–16.

Anderson, O. R. 1992. Some Interrelationships between Constructivist Models of Learning and Current Neurobiological Theory, with Implications for Science Education. *Journal of Research in Science Teaching.* Vol.19, No.10. pp. 1037–1058.

Aziz, T. and A. Rahman. 2014. Effect of Concept Mapping Strategy on Students' Achievement in Science at Secondary Level. *Research Gate. Available online: https://www. researchgate. net/ publication/281848894 (accessed on 17 September 2015).*

Bell, R. and L. Bell. 2002. A Bibliography of Articles on Technology in Science Education. *Contemporary Issues in Technology and Teacher Education.* Vol. 2, No.4. pp. 426–446.

Bera, S. and R. Mohalik. 2016. Effectiveness of Concept Mapping Strategy on Cognitive Processes in Science at Secondary Level. *European Academic Research.* Vol. 4, No. 4. pp. 3613–3630.

Bettaswamy, H. B. 2012. *A Study on Relationship between Scientific Attitude and Achievement in Science among IX Std Students of Mysore City Karnataka* (Doctoral dissertation, Regional Institute of Education, Mysore).

Brigham, F. J., T. E. Scruggs and M. A. Mastropieri. 2011. Science Education and Students with Learning Disabilities. *Learning Disabilities Research & Practice.* Vol. 26, No. 4. pp. 223–232.

Calvin, K. L. 2022. *Improving Expository Text Comprehension in Adolescent Spanish-English Bilingual Learners with Learning Disabilities Using a Graphic Organizer* (Doctoral dissertation, Arizona State University).

Chawla, J. and G. Singh. 2015. Effect of concept mapping strategy on achievement in chemistry of ix graders in relation to achievement motivation. *Asia Pacific Journal of Research.* Vol. 1, No.24. pp. 53–65.

Cheema, A. B. and M. S. Mirza. 2013. Effect of Concept Mapping On Students' Academic Achievement. *Journal of Research & Reflections in Education (JRRE).* Vol. 7, No. 2.

Ciullo, S., T. Falcomata and S. Vaughn. 2015. Teaching social studies to upper elementary students with learning disabilities: Graphic organisers and explicit instruction. *Learning Disability Quarterly.* Vol. 38, No. 1. pp. 15–26.

Dani, D. N. 1989. *Scientific Attitude and Cognitive Style.* New Delhi, Northern Book Centre.

Gakhar, S. C. and A. Kaur. 2014. Scientific Attitude Scale. National Psychology Corporation, Agra.

Hazare, R. 2018. Mini Review Curr Trends Biomedical Eng & Biosci Self-Explanatory Under Funded Project Study of Biology Concept Mapping Instruction as an Activator of Students' Performance in the Teaching and Learning of Excretion. *Current Trends in Biomedical Engineering & Biosciences.* Vol. 14. DOI: 10.19080/CTBEB.2018.14.555900

Hendi, W. F. A. 2015. The Effect of Concept Maps on Reading Comprehension Skills of Elementary School Students with Reading Disabilities. *Psycho-Educational Research Reviews.* Vol. 4, No. 2. pp. 46–51. Retrieved from https://www.perrjournal.com/index.php/perrjournal/article/view/331

Hwang, G. J., F. R. Kuo, N. S. Chen and H. J. Ho. 2014. Effects of an integrated concept mapping and web-based problem-solving approach on students' learning achievements, perceptions and cognitive loads. *Computers & Education.* Vol. 71. pp. 77–86.

Jack, G. U. 2013. Concept mapping and guided inquiry as effective techniques for teaching difficult concepts in chemistry: effect on students' academic achievement. *Journal of Education and Practice.* Vol. 4, No. 5. pp. 9–15.

Jatmiko, A., Y. Kartina, I. Irwandani, J. Fakhri, A. Pricilia and T. Rahayu. 2018. Reading Concept Map-Think Pair Share (Remap-TPS) Learning Model on Cognitive Ability and Scientific Attitude. *Jurnal Keguruan Dan Ilmu Tarbiyah.* Vol. 3, No. 2.

John, F., A. N. Sani, B. M. Ranccas and B. U. Maskawa. 2019. Effects of concept mapping and demonstration method on senior secondary two biology students' achievement in genetics in Jos North, Plateau State. *KIU Journal of Humanities.* Vol. 3, No. 4. pp. 177–182.

Kachhap, S., B. Devi and K. H. Mane. 2021. Concept Mapping for Diverse Learning Needs: Learning with Multiple Representations.

Kachhap, S. and K. H. Mane. 2019. Concept Mapping for Students with Visual Impairment: Practices and Challenges. *Journal of Disability Management and Special Education (JODYS).* Vol. 2, No. 1. pp. 6–15.

Karande, S., K. Bhosrekar, M. Kulkarni and A. Thakker. 2009. Health-related quality of life of children with newly diagnosed specific learning disability. *Journal of tropical pediatrics. Vol. 55,* No. 3. pp. 160–169.

Khan, S. A., S. M. A. Shah, Z. Mahmood and R. Zareen. 2012. Scientific Attitude Development at Secondary School Level: A Comparison between Methods of Teaching. *Language*

in India. Strength for Today and Bright Hope for Tomorrow. Vol. 12, No. 9. pp. 439–454. ISSN 1930–2940

Kumar, K. and J. Singh. 2017. Effect of Concept Mapping Strategy in Mathematics on Achievement and Mathematical Creativity in Relation to Anxiety in Mathematics. *GHG Journal of Sixth Thought.* Vol. 4, No. 1. R.N.I. No.: PUNENG/2014/59759. ISSN- 2348–9936

Madan, A. and N. Sharma. 2013. Inclusive Education for Children with Disabilities: Preparing Schools to Meet the Challenge. *Electronic Journal for Inclusive Education.* Vol. 3, No. 1. p. 4.

Marutirao, G. A. and P. S. Patankar. 2016. Effect of Concept Maps on Academic Achievement in the Subject Biology among the Higher Secondary Level School Students. *International Interdisciplinary Research Journal.* Vol. 6. pp. 79–85.

Morfidi, E., A. Mikropoulos and A. Rogdaki. 2018. Using Concept Mapping to Improve Poor Readers' Understanding of Expository Text. *Education and Information Technologies.* Vol. 23. pp. 271–286.

Mukund, K. 1988. The Hoshangabad Science Teaching Programme. *Economic and Political Weekly.* Vol. 23, No. 42. pp. 2147–2150.

National Education Policy. 2020. https:// www.mhrd.gov.in/ sites/ upload_files/ mhrd/files/nep/ NEP_Final_English.pdf referred on 06/05/2021.

Novak, J. D. and A. J. Cañas. 2009. The Development and Evolution of the Concept Mapping Tool Leading to a New Model For Mathematics Education. In *Concept mapping in mathematics* Springer, Boston, MA. pp. 3–16.

Novak, J. D. and D. B. Gowin. 1984, *Learning How to Learn.* Cambridge University Press, New York.

Olasehinde, K. J. and R. A. Olatoye. 2014. Scientific Attitude, Attitude to Science and Science Achievement of Senior Secondary School Students in Katsina State, Nigeria. *Journal of Educational and Social Research.* Vol. 4, No. 1. pp. 445. Retrieved from https://www.richtmann.org/journal/index.php/jesr/article/view/1862

Oliva, M. B. and B. Antonietta. 2012. Concept Maps and Learning Disorders, Concept Maps: Theory, Methodology. In *Technology Proc. of the Fifth Int. Conference on Concept Mapping.* Valletta, Malta.

Panditrao, M. M. and M. M. Panditrao. 2020. National Education Policy 2020: What is in it for a Student, a Parent, a Teacher, or us, as a Higher Education Institution/University? *Adesh University Journal of Medical Sciences & Research.* Vol. 2, No. 2. pp. 70–79.

Scruggs, T. E., M. A. Mastropieri and R. Boon. 1998. Science Education for Students with Disabilities: A Review of Recent Research.

Sharma M. and G. Singh. 2016. Effect of Collaborative Concept Mapping Strategy on Achievement in Economics of IX Graders. *Int. Edu & Research Journal.* Vol. 2, No. 9. pp. 22–24. ISSN 2454–9916.

Singh, A. and R. K Bajwa. 2017. Effect of Concept Mapping as an Instructional Strategy on Learning Outcome of Secondary School Students. *GHG Journal of Sixth Thought*. Vol. 4, No. 2. pp. 25–29.

Singh, S., V. Sawani, M. Deokate, S. Panchal, A. A. Subramanyam, H. R. Shah and R. M. Kamath. 2017. Specific Learning Disability: A 5 Year Study from India. *Int J Contemp Pediatr*. Vol.4, No. 3. pp. 863–8.

Singh, V. K., A. K. Singh and A. Giri. 2016. A Study of the Relationship between Scientific Attitude and Academic Achievement of Rural Area's Intermediate College Girls (Science Stream Only). *International Journal of Applied Research*. Vol. 2, No. 4. pp. 46–49.

Sperling, M., M. Grünke and C. Cöppicus. 2019. Graphic Organizer: An Efficient Tool for Learning-Disabled Students in a Museum. *International Journal of the Inclusive Museum*. Vol. 12, No. 4. pp. 57–66.

Steele, M. 2007. Teaching Science to Students with Learning Differences. *The Science Teacher*. Vol. 74, No. 3. p. 24.

Tandog, V. O. and C. O. Bucayong. 2019. Graphic Organizer: A Learning Tool in Teaching Physical Science. PEOPLE: *International Journal of Social Sciences*. Vol. 5, No.1. pp. 379–393.

Thomas, M. B. K. and M. G. R. Thakur. 2011. Effectiveness of Pictorial Concept Mapping in the Teaching of Science.

Undalok, J. M. B. and J. R. Salbabro. 2022. Dolch Sight Words in Concept Mapping as a Tool in Learning Word Recognition Skills for Learning Difficulty Learners. *International Journal of All Research Education & Scientific Methods*. Vol. 10, No.1. pp. 1353–1357.

Vlachos, A. and M. Zamfirov. 2017. Using Concept Maps to Teach Dyslexic Students Science: The Educators' Approach. *Open Journal for Educational Research*. Vol. 1, No. 2. pp. 91–108.