

CHAPTER 6 : SUMMARY AND CONCLUSION

The current study investigates three crucial characteristics that have the potential to impact academic achievement: Brain hemisphere dominance, Metacognitive awareness, and Perceptual learning styles. Brain hemisphericity refers to an individual's inclination towards using functions associated with one or both hemispheres of the brain during the execution of a task (Mansour et al., 2017). Metacognitive awareness pertains to the child's comprehension and capacity to regulate their own cognitive processes (Baker & Brown, 1984) and Perceptual learning styles refer to the methods through which learners gather information from their environment by utilizing their senses (Davis, 2007). These are the sensory channels they are most comfortable with (Oxford, 2001).

The statement of the problem has been formulated as: Brain hemispheric dominance, Metacognitive awareness and Perceptual learning style preferences as correlates of Senior secondary school students' Academic achievement in Biology.

6.1 Objectives of the study

1. To find out the Brain hemispheric dominance, Metacognitive awareness levels, Perceptual learning style preferences and Academic achievement levels in Biology of senior secondary school students.
2. To study the Brain hemispheric dominance, Metacognitive awareness, Perceptual learning style preferences and Academic achievement in Biology of senior secondary school students with respect to different demographic variables (gender and type of school).
3. To study the Brain hemispheric dominance, Metacognitive awareness and Perceptual learning style preferences of senior secondary school students with respect to their Academic achievement levels.
4. To investigate the relationship between Metacognitive awareness, Perceptual learning style preferences and Academic achievement of left brained and right brained students.

5. To investigate whether Metacognitive awareness and Perceptual learning style preferences would be significant predictors of Academic achievement in left brained and right brained students.

6.2 Hypotheses of the study

Hypotheses corresponding to Objective 2:

H₀1: Brain hemispheric dominance has no association with gender.

H₀2: There is no significant difference in the mean scores of Metacognitive knowledge with respect to gender.

H₀3: There is no significant difference in the mean scores of Metacognitive regulation with respect to gender.

H₀4: There is no significant difference in the mean scores of Visual learning style with respect to gender.

H₀5: There is no significant difference in the mean scores of Auditory learning style with respect to gender.

H₀6: There is no significant difference in the mean scores of Kinesthetic learning style with respect to gender.

H₀7: There is no significant difference in the Academic achievement scores with respect to gender.

H₀8: Brain hemispheric dominance has no association with type of school.

H₀9: There is no significant difference in the mean scores of Metacognitive knowledge with respect to type of school.

H₀10: There is no significant difference in the mean scores of Metacognitive regulation with respect to type of school.

H₀11: There is no significant difference in the mean scores of Visual learning style with respect to type of school.

H₀12: There is no significant difference in the mean scores of Auditory learning style with respect to type of school.

H₀13: There is no significant difference in the mean scores of Kinesthetic learning style with respect to type of school.

H₀14: There is no significant difference in the Academic achievement scores with respect to type of school.

Hypotheses corresponding to Objective 3:

H₀15: Brain hemispheric dominance has no association with Academic achievement levels.

H₀16: There are no significant differences among the mean scores of very high, high, average, low and very low achievers on metacognitive awareness.

H₀17: There are no significant differences among the mean scores of very high, high, average, low and very low achievers on perceptual learning style preferences.

Hypotheses corresponding to Objective 4:

H₀18: There is no significant relationship between Metacognitive awareness, Perceptual learning style preferences and Academic achievement in Biology of Left brained students.

H₀19: There is no significant relationship between Metacognitive awareness, Perceptual learning style preferences and Academic achievement in Biology of Right brained students.

Hypotheses corresponding to Objective 5:

H₀20: Metacognitive awareness and Perceptual learning style preferences would not be significant predictors of Academic achievement in Biology of Left brained students.

H₀21: Metacognitive awareness and Perceptual learning style preferences would not be significant predictors of Academic achievement in Biology of Right brained students.

6.3 Operational Definitions

Brain hemispheric dominance: In this study, it refers to the consistency of an individual in utilising cognitive functions that are associated with the left hemisphere or the right hemisphere, leading to left hemispheric dominance or right hemispheric dominance.

Some individuals are able to utilize cognitive functions associated with both the hemispheres in an equal and balanced way, leading to whole brain dominance. The brain hemispheric dominance of senior secondary students has been investigated with the help of the Brain Dominance Inventory (BDI) by Davis, Nur & Ruru (1994).

Left brainers/Left brained students: Students who consistently utilize functions associated with the left brain.

Right brainers/Right brained students: Students who consistently utilize functions associated with the right brain.

Whole brainers: Students who utilize functions associated with the left brain and right brain both in an equal way.

Metacognitive Awareness: In this study, it refers to having the knowledge about one's cognition and also having the ability to regulate one's learning. The Metacognitive awareness of senior secondary students has been measured with the help of the Metacognitive Awareness Inventory (MAI) by Schraw and Dennison (1994).

Perceptual learning style preferences: The way a person prefers to learn is their learning style and perceptual learning style preferences refers to the learning styles utilized by the students to learn Biology. In this study, the three perceptual learning styles are visual learning style (V), auditory learning style (A) and kinesthetic learning style (K). The perceptual learning style preferences of senior secondary students has been measured with the help of a self-developed tool.

Academic Achievement in Biology: It refers to the marks obtained by the students in the Achievement test in Biology which has been developed by the investigator for this study.

Senior secondary students: It refers to the students of Bio Science stream studying in Class XII with Biology as a major subject.

Gender: It refers to either males or females.

Type of school: It refers to either Private or Government senior secondary schools.

6.4 Delimitations of the study

The study was delimited to:

- Senior secondary students of Sikkim studying in Class XII.
- Students of Science stream studying Biology as one of the major subjects.

6.5 Research methodology

This study utilizes a descriptive survey method and the area of the study was the state of Sikkim, located in North East India. The population for the study includes all the senior secondary students from various government and private schools who have taken up the science stream, studying Biology as one of the major subjects in Class 12 and the sample consists of 635 students selected via cluster sampling. The research instruments used for the study were the Brain Dominance Inventory (BDI) developed by Davis et al. (1994), the Metacognitive Awareness Inventory developed by Schraw and Dennison (1994), Perceptual Learning Style Scale and an Achievement test in Biology both developed by the investigator for the study. The data obtained from the study were scored and analysed using the Statistical Package for Social Sciences (SPSS 25). The following statistical measures were used for analysing the collected data: Mean, Standard deviation, Frequency, Percentages, Bar graphs, Skewness, Kurtosis, Normality test, Chi square test, t-test, Pearson correlation and Regression analysis.

6.6 Major findings of the study

- Majority of the total sample (60.78%) are left brainers, followed by right brainers (39.20%).
- Out of 421 females, 62% are left brained and 38% are right brained, and out of 214 males, 58% are left brained and 42% are right brained. Also, out of 456 government school students, 63% are left brained and 37% are right brained, and out of 179 private school students, 55% are left brained and 45% are right brained.
- Majority of the students have average metacognitive awareness (59%). 36% of the students have high and 4% have very high levels of metacognitive awareness respectively. There were no students who had low and very low levels of metacognitive awareness.

- In case of both female and male students, majority have average level of metacognitive awareness, followed by high and very high levels. Also, in case of government and private school students, majority have average level of metacognitive awareness, followed by high and very high levels.
- 2.99% of students utilized visual learning style, 2.20% utilized auditory learning style and 5.51% utilized kinesthetic learning style. The highest percentage of students, i.e., 41.26% learnt Biology using VAK (Visual-Auditory-Kinesthetic), which was followed by 26.93% of students who utilized VA (Visual-Auditory) and 15.12% who utilized VK (Visual-Kinesthetic).
- Majority of the students were average achievers (74.33%), 23.15% were high achievers and 1.10% were very high achievers. There were 1.42% of low achievers and there were no students in the very low category.
- In case of females, majority have average level of academic achievement, followed by high, very high and low levels whereas in case of males, majority have average level of academic achievement, followed by high, low and very high levels. Also, in case of government school students, majority have average level of academic achievement, followed by high, very high and low levels whereas in case of private school students, majority have average level of academic achievement, followed by high, low and very high levels.
- Left brainers were distributed across all categories of students (Very high achievers, High achievers, Average achievers, Low achievers). Very high achievers had very high, high and average levels of metacognitive awareness and maximum number of students preferred VAK. High achievers also had very high, high and average levels of metacognitive awareness and maximum number of students preferred VAK, followed by VA and VK. Majority of average achievers had average levels of metacognitive awareness and maximum number of students preferred VAK followed by VA and VK. Also, there were 4% of students who had negligible preferences for either of the learning styles. In case of Low achievers, majority had average levels of metacognitive awareness and maximum number of students had negligible preferences for any learning style. Very few preferred VK and VA. None of the students had very low levels of academic achievement.
- Brain hemispheric dominance did not have any association with gender.

- There existed significant difference in the metacognitive awareness scores with respect to gender, with the mean scores of the females being higher than that of males.
- There existed no significant difference on the perceptual learning style scores with respect to gender.
- There existed significant difference in the academic achievement scores with respect to gender, with the mean scores of the females being higher than that of males.
- Brain hemispheric dominance did not have any association with type of school.
- There existed significant difference between students from government and private schools on the metacognitive awareness scores, with the government school students scoring higher on the metacognitive regulation component of metacognitive awareness.
- There existed no significant difference in the perceptual learning style scores with respect to type of school.
- A significant difference in academic achievement scores was found in relation to the type of educational institution, with the mean scores of the government school students being higher than that of private school students.
- Brain hemispheric dominance had no association with Academic achievement levels.
- There exist significant differences in the metacognitive awareness scores among very high, high, average and low achievers. The post-hoc test showed that there was significant difference among all the groups.
- There existed significant differences in the perceptual learning style preference scores among very high, high, average and low achievers. The post-hoc test showed significant differences in visual and auditory learning style mean scores among all the groups, except for high and very high achievers. Also, there were no significant differences in the kinesthetic learning styles among all the groups.
- There existed significant positive correlations between Metacognitive awareness and Academic achievement in both left brained and right brained students.
- There existed significant positive correlations between Perceptual learning styles and Academic achievement in both left brained and right brained students.

- In left brained students, the regression model explains 62.6 % of impact on Academic achievement and in right brained students, the regression model explains 64.6% of impact on Academic achievement.
- Metacognitive awareness and Perceptual learning styles are significant predictors of Academic achievement in both left brained and right brained students, which means that both categories of students are at par with each other and influence academic achievement in a similar manner in both categories of students.

6.7 Educational implications of the study

- The present study's findings revealed the prevalence of left-brainers and right-brainers. The absence of whole brainers leads us to understand that students are yet to be trained on how to utilize cognitive functions in an equal and balanced way. There is an inclination to preferentially employ the functions associated with one hemisphere more over the other for the purpose of learning. The less dominant hemisphere could be trained and strengthened. The "whole brain approach" to learning can be taught to prospective teachers in order to better understand how to promote whole brain learning in the classroom.
- The higher incidence of students with average metacognitive awareness in the sample indicates that their metacognitive awareness is still in the process of developing. There is a small number of students in the above average categories and no students in the below average categories. Given that the teacher is the main repository of knowledge and has the most interaction with students, it is crucial for teachers to be oriented on the range of metacognitive strategies that they might employ during the teaching-learning process. Several effective strategies that can be implemented in the Science classroom include Reflective journal writing, the IMPROVE approach, the POE (Predict-Observe-Elaborate) exercises, and the Model–Observe–Reflect–Explain (MORE) Thinking Frame.
- The findings on the perceptual learning styles of the students indicate that there are a minimal number of pupils who exclusively rely on a single learning type. The majority of individuals employ all three learning styles (Visual, Auditory, and Kinesthetic) as their major style. This highlights the necessity of using several forms of simulations in the classroom. Merely delivering lectures is

insufficient, since it can significantly impede the learning process for individuals who excel with visual representations, imageries, and interactive exercises. The most important educational implication that emerges out of this study is the necessity to effectively "balance" the learning environment and venture beyond the familiar realm of conventional teaching in order to investigate the various possibilities of utilizing ICT in the classroom.

- This study will assist educators in comprehending the value of communication and interaction in the Biology classroom for the purpose of identifying students' learning styles. Engaging in a meaningful conversation between educators and learners will enable them to recognize their cognitive inclinations, so allowing them to adapt their instructional approaches accordingly.
- The head of schools should conduct meetings with teachers and parents frequently to analyse the achievement of the students. This will enable them to gain a more accurate understanding of the progress over time. Given that children spend just one year in each class, it would be beneficial to continuously assess their progress as learners. It is imperative for parents to demonstrate equal interest and active participation in their child's cognitive development.
- Holistic education is one of the primary objectives of our educational system. It is essential that children possess the ability to utilize cognitive functions in a balanced way. They need to learn how to utilize the rational side of the brain and also the artistic and creative side of the brain. This study emphasizes the significance of developing a curriculum that can facilitate the development of both the hemispheres, hence promoting holistic development. Therefore, it is essential for teachers to receive thorough instruction and training in order to accomplish this objective.
- The present study revealed that brain hemispheric dominance was not associated with academic achievement, indicating that individuals with both left and right brain dominance can exhibit different levels of academic achievement. Individuals with a dominant left hemisphere of the brain tend to possess analytical thinking skills, whilst those with a dominant right hemisphere tend to possess creative and imaginative thinking abilities. To believe that only left brained students can excel in Science would be a misconception. Left brainers might not perform academically well if they don't know how and when to use

learning strategies and if they are unable to regulate their learning. On the other hand, right brainers might do well if they are self-aware and can monitor and evaluate themselves well. Both types of learners need to be nurtured and trained equally.

- This study demonstrates that metacognitive awareness plays a vital role in higher secondary education, as it is significantly and positively associated with students' academic achievement. This material can assist curriculum developers and educators in designing suitable curriculum, instructional techniques, and educational policies that foster metacognitive learning in science at the higher secondary level.
- Academic achievement and metacognitive awareness were both higher among female students than their male counterparts. The primary implication of this finding is that they should be provided with sufficient encouragement and social, financial, and educational support to pursue further education. It is imperative that societies become aware of the importance of educating the girl child since they possess a great deal of potential to improve their lives through education.
- Teachers, administrators, and students all need to be aware of the various ways that metacognition can be measured and evaluated. Educational institutions ought to embrace a comprehensive methodology that integrates ongoing formative assessments in the classroom, informal observations of instructors, and the use of self-report instruments. This approach has the potential to generate a comprehensive and nuanced assessment of students' metacognitive capacities, thereby enabling educators and administrators to devise more efficient instructional strategies.
- The researcher suggests that students' learning styles be identified early in their academic journey. Early identification of students' learning styles serves the purpose of notifying them of prospective academic weaknesses and providing instruction on ways to adapt their learning strategies.
- Gaining knowledge of students' preferred learning styles serves to discourage educators from treating all students identically and encourages them to transition from their preferred mode of instruction to utilizing alternative approaches. The findings derived from this research ought to persuade educators to implement diverse methods of information dissemination within the biology classroom. By

utilizing a variety of teaching strategies, instructors can better accommodate the learning styles of their students, thereby reaching a greater number of students.

- There was a significant and positive correlation between academic achievement and the visual and kinesthetic learning styles. The correlation with the auditory learning style was feeble, whereas a combination of all three learning styles was highly correlated. Therefore, it is the responsibility of policymakers and academic organizations to ensure that aspiring teachers have ample opportunities to gain training in various instructional methods, including demonstrations, hands-on activities, assignments, reading materials, and audio-visual aids. In reality, it is the responsibility of educators to remain current on the correct implementation and utilization of audio-visual aids.
- Using prior knowledge, teacher interviews, and classroom assessments, school principals should ascertain whether teachers' beliefs and behaviors foster student-centered learning environments wherein they are provided with guidance, support, and autonomy to independently navigate their own educational processes.
- Teachers have the ability to foster students' awareness of cognitive strategies through the implementation of reflective activities. Students may be encouraged to maintain a daily logbook in which they describe the learning processes they employ. Students acquire an understanding of alternatives to their own processes as they discuss their entries; the instructor can then direct and assist them.
- Curriculum planners and developers at the national and state levels should conduct workshops and seminars with the purpose of increasing educators' awareness regarding the potential of metacognitive approaches and the cognitive functions associated with the brain hemispheres.

6.8 Recommendations for further research

- The present study was conducted only on Class 12 students. Students across grades and different educational levels could be examined.
- The present study was conducted only on Biology students. The researcher recommends conducting research on students belonging to various streams and specializing in different subjects such that comparisons can be made for their similarities or differences.

- Cross-cultural studies could also be conducted to examine if their cross-cultural differences have an impact on their brain dominance patterns, metacognition levels, learning styles and academic achievement.
- Mixed method designs can be used to collect both qualitative and quantitative data on metacognitive awareness. Qualitative data can greatly help in elaborating and explaining the findings of the quantitative data. This will help in gaining better insight on cognitive factors that influence learning.
- Case studies can be conducted on whole brained students who are capable of utilizing the cognitive functions associated with both hemispheres of the brain equally.
- Cross-body connections between the hemispheres of the brain have been documented in the literature. This suggests that the right brain exerts control over the left side of the body, whereas the left brain over the right side. This aspect could also be studied utilising a multidisciplinary approach.
- Experimental investigations can be undertaken in different levels of education to implement and test modules that have been constructed to train and enhance various cognitive facilities.
- Metacognitive awareness could also be studied in combination with other cognitive factors such that their interaction effects, moderating effects and mediating effects on academic performance can be examined.
- A similar study with a larger sample of children from various types of schools in different states and areas in India can be conducted.
- Research on children with learning disabilities can also be conducted.
- Research can be conducted taking not just students but teachers as well to see what their teaching styles are in the Biology classroom.
- Teachers' perceptions and reactions to metacognitive learning in teaching scenarios can be examined.
- Longitudinal studies can be conducted to understand whether the metacognitive awareness of students significantly increases with advancing academic structure.
- In the present study, only the perceptual learning styles of the students were investigated. In future, studies with other learning styles and their relation to different cognitive strategies can be carried out.

- In the current study, demographic variables like gender and type of school have been included. Other demographic variables such as locality of school, academic streams, socio-economic status etc. can also be taken up.
- Other factors that affect academic achievement like mental health, emotional intelligence, spatial intelligence, school environment, etc. can be studied.

6.9 Conclusion

The "one method fits all" approach to education is incompatible with a diverse population (Spector, 2013). At present, it is critical to educate and raise learners' consciousness regarding the importance of harnessing their potential to obtain optimal results in terms of academic performance. In the contemporary competitive society, individuals with various aptitudes and opportunities are evaluated uniformly via examinations. The responsibility of cultivating students' academic success rests with educators and all stakeholders involved in the field of education. Understanding the influence of brain hemispheric dominance, metacognitive awareness and perceptual learning styles on academic achievement has been elucidated through the current investigation. The development of metacognitive awareness is indispensable for equipping individuals with the necessary skills to actively participate in their continuous education. Gaining insight into the learning style preferences of students can help educators in devising effective instructional approaches, ultimately contributing to students' academic success. Furthermore, the study's results offer insights into the manner in which students with left and right brains operate with comparable efficiency and metacognitive awareness. Also, they indicate how learning styles and metacognitive awareness can serve as significant predictors of academic achievement. Science education necessitates not only rationality and logic, but also imagination and creativity. In the current era, it is critical that science students cultivate a well-rounded cognitive capacity. It is imperative that an educator recognize the varied requirements of the pupils and establish a dynamic learning environment that accommodates all categories of learners while offering ample opportunities to enhance their cognitive capacities.