Short Research Article

Learners' Perceptions and Academic Achievement Using Thinking Maps in Learning Class Nine Chemistry

ABSTRACT

Teaching Science innovatively has become a key motivation in educational parlance to uplift the academic achievement of the learners. There are numerous teaching strategies and skills developed by educationists, researchers and teachers to teach the subject creatively in the classroom. Thinking Maps is one such teaching strategy that enables the learner to make their thought processes visible during the learning processes. Although there are several studies indicating the positive impacts of using Thinking Maps as a teaching-learning strategy, there is no established study conducted in the Bhutanese context to investigate its effectiveness. The study on learners' perception and academic achievement on the use of Thinking Maps as a learning strategy in class nine chemistry was aimed to investigate the effectiveness of using Thinking Maps as a teaching strategy in Damphu Middle Secondary School (DMSS). The pre-test and post-test were administered for both control and experimental groups to examine the performance level in chemistry before and after the intervention. Similarly, five-pointed Likert-type item survey questionnaires were administered for the experimental group to examine the influence of learners' perceptions. In addition, anecdotal records were maintained throughout the treatment for qualitative information. Results were analysed using descriptive and inferential statistics. Document analysis was done for the anecdotal records. While pre-test and post-test showed a change in mean test scores, rating scores from survey questionnaires indicated a positive impression towards Thinking Maps as a learning strategy. The overall findings indicated that the use of Thinking Maps as a teaching-learning strategy improves learners' achievement scores. It is recommended that teachers incorporate Thinking Maps as an alternative strategy into their lesson delivery.

Keywords: *Thinking Maps, Teaching Strategies, achievement test, pre-test, post-test.*

1. INTRODUCTION

The Science curriculum in Bhutan has undergone tremendous change since the inception of Modern Education in the 1950s. Today with the successful introduction of new Science curricula from classes IV-XII, Bhutan currently has a new Science Curriculum more relevant to our natural and social environment. The relevant and appropriate pedagogy at all levels of science education in Bhutan has undergone an entire overhaul in the present times (1). Similarly, science has become an indispensable subject that requires a higher level of cognitive thinking to promote coherent and comprehensive education for the 21st-century learners in Bhutan similar to the global context.

Science education has been given paramount importance in Bhutan in gearing towards Science, Technology, Engineering and Mathematics (STEM) Education (1) as science and technology have progressed to make education affordable, accessible and effective. Similarly, science helps young minds become more creative, innovative, explorative, and analytical, ultimately fostering locally rooted and globally competent individuals. Nevertheless, the root of these qualities lies in the learners' ability to think independently. To materialise this aspiration, the teachers need to incorporate the effective pedagogical approach that motivates learners to think and engage in learning.

In recent years, making thinking visible has gained its trend in the educational arena due to multiple positive impacts on learners' learning. For instance, when learners are encouraged to represent their thought processes into visual forms, they are motivated to learn better as it develops the conceptual understanding of the learning concepts (2). In addition, it is also claims that the brain is a pattern detector and learns better with patterns (3). This means when learners are presented with a pattern for the concepts, the level of conceptual understanding is higher. One of the ways to make the thought processes visible is through the use of Thinking Maps as a teaching strategy by the teacher. It has been found that the use of Thinking Maps develops the thinking skill, organisation skill, improved quality and quantity of writing and motivates the learners (4). Further, Thinking Maps helps teachers to organise content and assess student learning.

It is inevitable for the teachers to possess an effective way of teaching and learning experiences to give life to the curriculum. Likewise, incorporating relevant and appropriate teaching-learning strategies by the teacher is a key component in scaffolding the learning abilities of learners. Although teaching science with creativity and innovation has always been a challenge for the science teachers at DMSS, practising a variety of pedagogical approaches in the classroom including Thinking Maps are prevalent which supports different domains of learning.

The implementation of transformative pedagogy in 2016 enabled learners to leverage active participation in the class, construct their own knowledge, or feel motivated and develop self-confidence (5). In contrast, there are also challenges faced in real classroom settings such as more number of learners in the class and the vastness of the syllabus (6). Similarly, Hyerle and Alper, (7) also asserted that "in cooperative learning, one of the most difficult tasks is to assess individual participation within group work" (p.32). It is also evident that teachers use minimum visual aids in teaching-learning processes (8). Therefore, it is deduced that there is a need to upgrade the teaching skills and strategy to further improve the educational standard more relevant to 21st century learners.

One such teaching strategy is the integration of Thinking Maps into our classroom instruction delivery. Thinking Maps are found to be one of the instructional strategies that can reinforce the learning process. Hyerle (3) posits that Thinking Maps are sets of visual graphic tools which are based on the thought processes helping learners to reach higher levels of critical, and creative thinking thereby enhancing academic achievement. Although several studies have indicated the enhancement of learners' motivation for learning and upscaled academic achievement using the Thinking Maps (8,9), there are very limited empirical studies carried out in the Bhutanese context. In fact, it is imperative that no study is conducted to confirm the impacts of using Thinking Maps in Bhutanese classroom settings. Therefore, in an attempt to teach science innovatively and creatively in DMSS, this study aspires to study a learners' perceptions and academic achievement on the use of Thinking Maps in Chemistry. Similarly, the study enabled the research team to reflect and articulate the pedagogical approaches in the teaching of Chemistry in DMSS. Furthermore, this study also established baseline data for future research.

Objectives

1. To determine the effectiveness of Thinking Maps on academic achievement in learning Chemistry.

2. To explore the learners' perception towards learning Chemistry using Thinking Maps.

2. LITERATURE REVIEW

Thinking Maps

It is not unusual for teachers to encounter myriads of challenges in the 21st-century classroom. Teachers are constantly posed with challenges on how to best model the instructional strategies to fit learners' diversified learning styles. To optimise the learning in such a classroom environment, a teacher must implement strategies that accommodate the academic needs of every child in the classroom. For this, there are many teaching skills and strategies developed by educationists and researchers, to include few; cooperative learning, inquiry based, problem based and project based. Thinking Maps are one such tool developed by David Hyerle in 1988 (10). According to Hyerle, Thinking Maps are 8 visual-verbal graphic tools (refer to Table 1), each based on fundamental thinking processes and used together as a set of tools for showing relationships (11).

Table 1 Thinking Maps and its descriptions

Type of Thinking Maps	Uses
Circle Maps	used for defining in context
Bubble Maps	used for describing with adjectives
Double Bubble Maps	used for sequencing and ordering events
Tree Maps	used for identifying part/whole relationships
Brace Maps	used for classifying or grouping
Flow Maps	used for comparing and contrasting
Multi-Flow Maps	used for analysing causes and effects
Bridge Maps	used for illustrating analogies

Adapted from: Hyerle and Yeager (2007, as cited in 11).

Given its positive impact on student motivation and academic outcome, Thinking Maps has got its place in education as one of the reputed teaching tools. It has been shown to foster learners to reach higher levels of creative and critical thinking thereby enhancing motivation and academic achievement (13). For instance, when Thinking Maps are used as teaching tools, there is an indication of learners thinking visually and able to make a reference in transferring new knowledge into their world of experiences and perceptions (7). Similarly, Thinking Maps are found to be useful tools in enhancing the learners' motivation, building up confidence and ultimately making them independent learners (14). Further, Holzman (15) posits that Thinking Maps represent thinking of the student during the learning processes and it is applicable to all grade levels across the curriculum.

Several studies have been carried out to validate the efficacy of Thinking Maps on learners' motivation and academic achievement. In one of the studies by Al-naqa and Abu-Owda (16), it was found to have a positive impact in raising the level of scientific knowledge of science processes. Similarly, the authors deduced that Thinking Maps helps learners in raising their attention, and remembering the greatest possible number of concepts. In addition, a study by Mansoor et al., (17) showed a significant increase in learners' ability to transfer knowledge into real-life situations. Therefore, the inference has been drawn that the use of Thinking Maps as teaching tools have tremendous benefits in motivating the learners and improving their academic achievements.

Although there is a plethora of discussion about the benefits of using Thinking Maps in classroom environments as a teaching and learning strategy, there are limited established studies with regard to the Bhutanese classroom setting. Hence, this study explored Learners' Perception and Academic Achievement using the Thinking Maps as Learning Strategy in Chemistry for Class Nine Learners.

2.1 CONCEPTUAL FRAMEWORK

This study analysed learners' perception and also gauged academic achievement in Chemistry by the use of Thinking Maps as a learning strategy through the conceptual framework (refer to Figure 1).

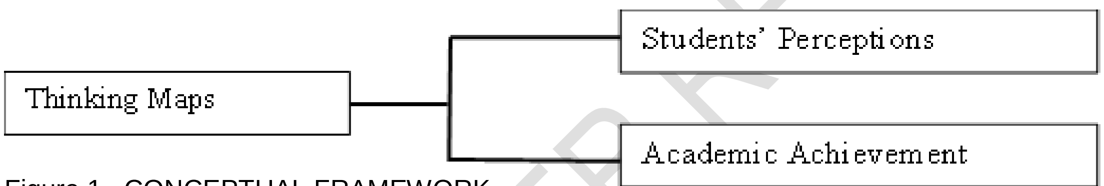

Figure 1 . CONCEPTUAL FRAMEWORK

2.2 MEANING OF PERCEPTIONS IN THE CONTEXT OF THIS STUDY

In a general context, perceptions are the opinions of an individual often resulting either from experiences or from external stimulus on the individual. It has been described that perception can be a means of understanding reality and experiences through senses, hence allowing judgement of figure, behaviour, and action (18). However, in the context of this study, perceptions are views and opinions of learners towards Thinking Maps as a learning strategy. The perceptions of learners towards Thinking Maps can be either positive or negative depending on the individual's feelings, emotions, and attitudes.

Although different people have a different perception of the same object or situation, it has been described that an individual's perceptions can be understood through their interpretations and behaviours (18). This means that perceptions influence an individuals' opinions, understanding, and meaning of an experience, judgements, and the way of responding to situations. Human behaviour is guided by thoughts and beliefs (19) and knowing learners' perceptions would help better understand the effectiveness of Thinking Maps as a learning strategy.

In conclusion, the literature related to Thinking Maps were reviewed to develop a deeper conceptual understanding. The review of the literature suggests that when learners are introduced to the Thinking Maps, they visualise the abstract content knowledge and represent it on paper. Similarly, for teachers, the Thinking Maps becomes a toolset for supporting effective instructional strategies to improve student performance. While several previous studies have shown increased academic achievements by using Thinking Maps as a teaching strategy, there is little evidence relative to the Bhutanese context. Therefore, this study added to the existing literature in the Bhutanese context through the following two research questions:

Research Questions

1. How significant is Thinking Maps in learning Chemistry?
2. What is the learners' perception in learning chemistry using Thinking Maps?

3. RESEARCH DESIGN AND INSTRUMENTS

A study on "learners' Perception and Academic Achievement using Thinking Maps as Learning Strategy was addressed through a quantitative method using a quasi-experimental research design. The research team employed pre-test and post-test to compare learners' achievement (refer to Figure 2). For learners' perception, questionnaires were administered to analyse their perception which is adapted from Wilson, Copeland-Solas & Guthrie-Dixon, (20). The perceptions were then categorised into five degrees of interpretation (refer to Table 2) using Best and Kahn's (21) criteria and mean score were compared to the pre-set criteria. Best and Kahn indicate that each grouping needs to maintain an interval width of .80 as shown in the formula below:

The width of class interval$=\frac{highest\ score - lowest\ score}{number\ of\ levels}$

$$= \frac{\mathbf{5-1}}{\mathbf{5}} = \mathbf{0.8}$$

Table 2. Scale for interpreting the mean values of perception levels

Mean Score	**Level of Perceptions**
1-1.80	Strongly Disagree
1.81-2.60	Disagree
2.61-3.40	Neutral
3.41-4.20	Agree
4.21-5.0	Strongly Agree

Similarly for qualitative data, classroom observation was done during the administration of intervention. Anecdotal records for any observable behaviour change were recorded and triangulated to validate the data.

3.1 PARTICIPANTS AND SAMPLING

The participants for the study were two sections of class nine learners of DMSS (n = 59). The participants were selected based on convenience sampling due to the fact that all the research teams are teaching the same class. One section was selected as the experimental group (EG) and another control group (CG). The experimental group were taught using Thinking Maps and the control group using the traditional method.

3.2 DATA ANALYSIS PROCEDURES

The data were analysed using Statistical Packages for Social Science (SPSS version 26). The research team analysed descriptive statistics such as frequency counts, percentage, mean and standard deviation and inferential statistics for achievement tests. Similarly, learners' note taking and notebooks were observed and analysed and triangulated.

3.3 ADDRESSING ETHICAL ISSUES

Educational research involves people in the community which requires social and cultural considerations. Moreover, all human behaviours and actions are subject to ethical principles (21,22). To minimise the possible risk that the research processes may cause in with the participants, the research team complied with the core standards of ethical practices, confidentiality and consent while collecting the data. The procedurals and ethical requirements were taken into priority. The approval was also taken from the school administration while the consent was taken from all the participants that their participation is voluntary and may withdraw from any part of the study anytime should there be inconvenience.

4. RESULTS

A total of 59 class nine learners participated in this study. Out of 31 learners in the control group (CG), 15 were female and 16 were male. Similarly in the experimental group (EG), 18 were female and 10 were male totaling up to 28.

In an attempt to compare the learners' performance, pre-test and post-test were administered for the participants before and after the treatment was given. The pretest was intended to examine the existing learning abilities and background knowledge of the learners for both CG and EG. Likewise, the post-test was intended to find the differences in the learning achievement after the completion of the intervention. The results for perception questionnaires and class observations were analysed to couple up the pre-test and post-test results.

4.1 COMPARISON OF PRE-TEST RESULTS

To identify the CG and EG, the test score from the pretest was subjected to an independent t-test. Although there was a difference in the mean score for CG (M=11.35, SD=3.37) and EG (M=10.89, SD=3.69) as shown in Table 1, the result indicated that there is no statistical significance between the groups in the knowledge of green chemistry before the intervention of the study (t=0.58, $P > .05$). This was an indication that both the groups were similar in their abilities before the intervention was given. Therefore, it was deemed tenable to conduct an experiment to compare the means. The lowest mean score of pre-tests was identified as the EG.

Table 3. Test Score Differences in Pre-Test between Control and Experimental Group

	Group	N	Mean	SD	T	Sig.
Pre-test	CG	31	11.35	3.37	-0.58	0.56
	EG	28	10.89	3.69		

*Significance level *(P = .05)*

4.2 COMPARISON OF POST-TEST RESULTS

To evaluate the prevalence of a statistically significant difference between the mean score of post-tests between the CG and EG, the test score was computed. Levene's Test for Equality of variance shows no violation with $P > .05$ (Table 3). Therefore, t-statistics assuming homogeneity of variance was computed. The result of the computed mean score was subjected to an independent sample t-test. The result showed that there are significant differences between the mean performance scores of CG (M=15.42, SD=2.65) in comparison to EG (M=20.82, SD=2.82) with the level of significance at .05 with conditions; t (57) = -7.56, *P* =< .05 (refer Table 2).

Table 4. Test Score Differences in Post-Test between Control and Experimental Group

	GROUP	N	Mean	SD	T	Sig.

Post-test	CG	31	15.42	2.65	-7.56	0.00
	EG	28	20.82	2.82		

*Significance level *(P = .05)*

Table 5. Test Score Difference between the CG and EG on their Pre-Test and Post-Test Score

Independent Samples Test						
		Levene's Test for Equality of Variances		t-test for Equality of Means		
		F	Sig.	t	df	Sig. (2-tailed)
Pretest	Equal variances assumed	.888	.350	.502	57	.617
	Equal variances not assumed					
Posttest	Equal variances assumed	.119	.731	-7.565	57	.000
	Equal variances not assumed					

4.3 ANALYSIS OF QUESTIONNAIRES ON LEARNERS' PERCEPTION ON THINKING MAPS

The five-pointed Likert item questionnaires were employed by the EG after the intervention to investigate the perceptions on the use of Thinking Maps in learning Green Chemistry. The questions consisted of 10 items around applicability, effectiveness, attitudes, interest and perceptions. All the learners from EG responded to the questionnaires. The questions were computed for means and standard deviation using Microsoft Excel 2019. The mean values used for the degree of interpretation was based on Best and Kahn's (21) interval ratio.

The result indicated a trend that Thinking Maps are useful to make learning easy and concrete. This is evident from the degree of interpretation on the level of agreement as 90% (9 out of 10) of the items are within the range of 3.41-4.20 (refer to Table 5).

Table 6. Item-wise Rating of Learners' Perception towards Thinking Maps

Sl.No	**Items on the Use of Thinking Maps**	**Mean**	**SD**	**Degree of Interpretation**
1	Thinking Maps are useful.	4.32	0.90	Strongly Agree
2	Thinking Maps are easy to create.	3.96	0.79	Agree
3	Thinking Maps are fun to create.	3.96	0.92	Agree
4	Thinking Maps make chemistry learning easier.	4.14	0.97	Agree

5	Thinking Maps increase engagement in class.	3.79	0.99	Agree
6	Thinking Maps helped me identify gaps in my understanding.	3.89	0.88	Agree
7	Thinking Maps helped my teacher to see what I did not understand.	3.68	1.06	Agree
8	Making Thinking Maps helped me to communicate with my peers about the topic.	3.96	0.79	Agree
9	Talking to my peers about the topic helped my understanding.	3.89	0.99	Agree
10	Thinking Maps helped me to revise.	4.04	1.00	Agree

4.3 CLASSROOM OBSERVATION

Learners of EG were observed in the processes of carrying out learning tasks during a three weeks intervention period. Analysis of the anecdotal records showed that learners developed more curiosity and interest when different types of Thinking Maps (refer to Table 1) were introduced. It was interesting to observe a trend that learners were motivated to take part in the discussion and the frequency of seeking clarification increased over the period of three weeks.

5.DISCUSSION

The study on “learners’ Perception and Academic Achievement on the Use of Thinking Maps as Learning Strategy in Class Nine Chemistry” was intended to develop an understanding on how learners perceive the Thinking Maps when it is used as a learning strategy. In addition, the study aspired to investigate the academic performance of the learners after the treatment with Thinking Maps.

The current study has gone some way towards enhancing deeper understanding on the applicability and effectiveness of Thinking Maps as learning strategy in learning of Chemistry. The main findings of the study are discussed in relation to research questions as follows:

Research Question 1

How significant is Thinking Maps in learning Chemistry?

To investigate the level of significance of using Thinking Maps as a teaching strategy in learning Chemistry, an achievement test was conducted after the intervention for both CG and EG. The result of the Independent Samples t-test confirmed that Thinking Maps are highly effective in teaching and learning processes. Although the mean difference between the CG and EG for the pre-test is 0.46 (refer to Table 1), the mean difference for the post-test is 5.4 (refer to Table 5). This indicates that Thinking Maps are effective in learning Chemistry.

This finding is concurrent to several other previous studies which indicated that use of Thinking Maps in classroom teaching has positive impacts on learning (8,3). Similarly, the finding also objectively aligns to Hyerle & Alper's (7) claim that when Thinking Maps are used as a teaching tool, learners are able to make their concepts visible to transfer in the new context (17). Further, the increase in the mean score of the CG and EG can be correlated to the assumption that our brain is a pattern detector (3) and learns better with visuals.

The possible reasons for the significant increase in the test scores of EG could be due to the immense implication of intervention. This is because there was a shift from the traditional paradigm of teacher-centred teaching to a paradigm of learner-centred learning. This gives a grounding to postulate that EG in which the treatment was given has outperformed CG.

Research Question 2

What is the learners' perception in learning Chemistry using Thinking Maps?

In an attempt to examine the perception of learners towards the use of Thinking Maps as a learning strategy, perception questionnaires were administered towards the end of the intervention. The finding indicated a trend that Thinking Maps are useful to make learning easy and concrete. This is evident from the degree of interpretation on the level of agreement as 90% of the items are rated "Agree" and "Strongly Agree" (refer to Table 4). Observation of such trends is important as this indicates the level of positive impression by the learners in using the Thinking Maps during the learning process. Since perception is a means of understanding reality and experiences, the observation of positive impressions indicates that people have positive views on using Thinking Maps.

Classroom Observation

Based on the result of this study, it can be deduced that the intervention for the EG with the use of Thinking Maps has induced a positive impression for the learners. For example, during the observation period, it was found that learners develop more curiosity and interest when different types of Thinking Maps were introduced. It was interesting to observe an increased level of motivation for learning and classroom discussion. In addition, learners were also able to apply different Thinking Maps into the learning of new concepts (refer to Figure 2). This observation corroborates the claim by Hyerle and Yeager (13) that the use of Thinking Maps scaffolds the learners to attain higher levels of creative and critical thinking which leads in enhancing motivation and academic achievement.

6. CONCLUSION

The ontological aspects of "Learners' Perception and Academic Achievement on the Use of Thinking Maps as Learning Strategy in Class Nine Chemistry" was approached through a quantitative method. The data were collected using pre-test and post- test in addition to perception questionnaires while the qualitative data was collected from the analysis of classroom observation. The study concluded that the use of the Thinking Maps had a significant impact on learners in learning Green Chemistry. This is evident from the increased mean scores of the achievement test and positive impression from the perception of the learners. In addition, the classroom observation revealed that when the Thinking Maps were used as teaching-learning strategy, learners developed more curiosity and interest.

In conclusion, Thinking Maps is a fairly excellent teaching-learning strategy that helps learners to learn abstract concepts more easily through visual presentations. Similarly, for teachers, it is a set of tools for making the concept more concrete. Therefore, the study confirms that Thinking Maps is one of the effective teaching-learning strategies especially relative to the Bhutanese classroom setting.

7. LIMITATION, IMPLICATIONS, AND RECOMMENDATION

Although the study revealed a significant impact on the enhancement of academic test scores, there are certain limitations:

1. Finding included only one class level (n=59) and may not generalise to the larger population.
2. The findings are only from Chemistry subjects and do not include other subjects.

The study has confirmed the effectiveness of Thinking Maps as there was an enhancement in the academic test score. This implies that there is a need to apply such a strategy in our daily classroom teaching by practising teachers.

With the positive findings from the study, it is recommended that the Thinking Maps may be used as one of the 21st-century teaching-learning strategies. Since the study included only one subject and had less sample size, it is recommended to replicate the study with the incorporation of multiple subjects and increase the sample size to generalise the findings to a larger population.

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