



## Effect of Dual Modality of Presenting Information on Students' Achievement in a Science Unit

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### ABSTRACT

This experimental study investigated the effect of dual modality of presenting information using both visual and auditory modes on students' academic achievement in General Science at the pre 9th grade. Grounded in John Sweller's Cognitive Load Theory, the study tested the hypothesis that students taught through dual modality would outperform those taught through a single modality. The sample comprised 36 female students from FG Public School (Girls), Lalazar, Rawalpindi, divided into experimental and control groups based on matched pretest scores. The experimental group received instruction through visual and auditory materials (e.g., diagrams, models, PowerPoint presentations), while the control group was taught using a lecture-based, single-mode approach. Data were collected through pretest and posttest instruments and analyzed using mean, standard deviation, and independent samples t-test at a 0.05 significance level. Results revealed a statistically significant difference in posttest achievement scores in favor of the experimental group ( $t = 3.138, p < 0.05$ ), confirming that dual modality instruction enhances learning outcomes and retention. The findings support the modality effect proposed by Cognitive Load Theory, suggesting that integrating visual and auditory channels reduces cognitive overload and improves conceptual understanding. It is recommended that science teachers employ dual modality presentations to promote deeper learning and engagement among students.



## Introduction

Modality effect is a central issue in John Sweller's cognitive load theory. Cognitive load theory is a theory that focuses upon the load on working memory during instruction. It suggests that learners can absorb and retain information effectively if dual modes of presenting the information (visual and auditory) are applied instead of using a single mode of presentation. The present study was aimed to verify this theoretical assumption of cognitive load theory by exploring the effects of dual

modality on students' learning a science unit. The objectives of the study were to explore the effect of dual mode of presentation on achievement of the experimental group, to examine the effect of single mode of presentation on achievement of the control group and to compare the achievement of both the groups.

The hypothesis of the study was that there would be a significant difference in the mean post-test achievement scores of the experimental group taught through dual mode of presentation and control group taught through single mode of presentation. The above research hypothesis was tested through the null hypothesis that there would be no significant difference in the mean post-test achievement scores of the experimental group taught through dual mode of presentation and control group taught through single mode of presentation.

The study was designed to be experimental in nature. A kind of true experimental design "Test retest control group" design was used to conduct the study. 36 students from pre IX Class of FG Public School (Girls), Lalazar, Rawalpindi were assigned to two groups consisting of 18 students in each group by matching their pretest scores. The experimental group received the instruction through dual mode and the control group through single modality. The students were engaged in the experiment for four weeks, for one period of 35 minutes a day. Two tests i.e. Pre-test and Post-test were used to measure the student's achievement before the experiment and after the experiment respectively.

The data was analyzed by using mean, standard deviation and by comparing the post test scores through two-tailed t-test for independent samples. The level of significance used to test the hypotheses was 0.05. The results of study supported the theoretical assumption of dual modality effect of cognitive load theory that students learnt more in the subject of general science when they were presented information both visually and auditory as compared with when they were presented information auditory alone.

### **Statement of the problem**

Education is considered as the cheapest defense of a nation. Scientific education especially outlines the basis for national development. Lamentably, we have not prevailed with regards to making science instruction successful for the students and in addition for the improvement of the nation. An attempt on the part of individual teachers or schools to progress students' education and outcome in science needs to be conscious of the complicated nature of the learning in science.

Research in science training has built up that the accomplishment level of students in learning science is actually connected with teaching techniques. Science is a hypothetical and composite thought and because of these characteristics, it is particularly challenging to be understood easily by words alone. Woolnugh (1994) has suggested that people cannot obtain an absolute understanding of science from simple teaching. Therefore, it is stressed that this subject teacher should be well equipped with innovative methods and unconventional techniques. In most schools, Science teachers use teaching methods which are not suitable. It makes the students feel bored in the class and thus they start to lose interest in the subject. This is the reason for poor learning of students in science. Hence, a large number of students fail to take admission in science subjects.

Cognitive load theory is an alternative to overturn this deadlock in science learning. The principle ideology of this theory is that the worth of educational plans will be lifted if more importance is given to the function and the confinement of working memory. Working memory has a split system for processing verbal and non-verbal data. A proposal is that the handling range of working memory can be extended by spreading information across both frameworks. This will permit the

learner to ingest the information and lessen the cognitive overload. In this manner this review investigated the impact of dual modality on learner's attainment.

### **Purpose of the study**

The purpose of this research was to examine the effect of dual modality of presenting information on academic achievement in General Science subject to the pre IX grade arts students from F.G. School (Girls), Lalazar, Rawalpindi.

### **Literature Review**

Cognitive load theory (CLT) is a theory that focuses upon the load on working memory during instruction. CLT suggests that learners can absorb and retain information effectively if dual modes of presenting the information (visual and auditory) are applied instead of using single mode of presentation.(visual or auditory).CLT constructs upon the most recognized model of human information processing, searched out by Richard Atkinson and Richard Shiffrin in 1968 (Ormrod, 2008).

In modern practice, the term "information" refers to views and facts collected and provided during everyday life. Information processing is the way in which data is stored, manipulated and transformed. It is an approach with a target of understanding human thinking. Information from the sensory memory passes into working memory, where it is either prepared or dismissed. When working memory has processed information, it moves it into long-term memory, where it is put away in learning structures called "schemas." Schemas classify data as per how we utilize it. There are a number of postulates that form the basis of information processing approach:

- First of all, available information from the environment is proceeded using a variety of systems for instance attention, short-term memory and perception;
- These systems reproduce the information in a logical form and the information processing system in human beings can be compared with computers (McLeod, 2008).

A theory of cognition was displayed by Allan Paivio of the University of Western Ontario in 1971.In building up this hypothesis; Paivio used the arrangement of mental pictures to help in teaching (Reed, 2010). According to **Paivio**, there are two means a man could create on scholarly material:

I. Verbal affiliations

II. Visual imagery

Paivio's perspectives created a better memory in light of the fact that the visual picture holds more detail than does the verbal code.

**Alan Baddeley** (1974) likewise incorporates a two piece dealing system in working memory i.e. a visuospatial sketchpad and a phonological loop which mainly matches with Paivio's theory. In his opinion, the working memory system has a TRIPARTITE STRUCTURE consisting of a supervisory " central executive" and two slave frameworks, the "phonological loop" and the "Visual - spatial sketchpad." Each of the parts of working memory has restricted capacity.

**Sweller (1992)** the founder of CLT,said that, since working memory has a narrow power, teaching techniques should keep away from overloading it with extra activities that don't straightforwardly contribute to learning.The basic standard of CLT is that the nature of instructional outline will be

more noteworthy if consideration is paid to the part and impediments of working memory. It depicts learning with regards to a framework of data preparation that is formed by long-term memory.

According to the CLT, the amount of mental effort involved in the working memory forms the cognitive load. So, it is the mental activity amount that is compulsory for working memory at a certain time limit. And cognitive load means having overloaded information which makes it difficult for a person to remember anything. There are three sorts of cognitive load; Intrinsic, Extraneous and Germane cognitive load. All these three loads combine to form a total working memory stack presented to the learner during learning.

CLT highlights several practices that can be applied to training and performance improvement. The most basic of these are strategies for reducing the impacts of external cognitive instructional material loads so that optimal learning can occur. Some of them are positive as they explain guidelines to create teaching materials. Some of them, however, are negative as they hinder learning. The **Modality effect** is one of positive methodologies applied to reduce the effects of external cognitive load. The methodology impact happens when data is displayed in two distinctive sensory modalities, for instance, when printed data is given in the sound-related frame, and the diagrammatic information is instantly visually. By utilizing both sound-related and optical channels, an adequate Working Memory (WM) limit is expanded. This extended WM can be utilized to decrease mental workload and results in preferred learning over identical, single-mode presentations that alone use visual data. As indicated by CLT, working memory limits with regards to learning can be adequately created when graphical data is displayed optically, and literary evidence is introduced discernibly. Conversely, if all the information is exhibited visibly, learners' working memory limit will be over-burdened, and learning will be hindered. Like this, showing data in both the visual and sound-related modes will build the working memory limit (Mousavi, 1995).

Dual mode of presenting information reduces mental workload on working memory and results in better learning. Effective understanding of scientific explanations requires a mapping between visual and verbal information as working memory has two parts: visual working memory and verbal working memory. A few reviews have presumed that learning is more effective when many tactile trails are utilized to present data (Mayer 1997, 2001). The methodology standard says that if data (charts, outlines, or liveliness) is introduced over various modalities (visual and sound-related), more powerful learning will come about than when the data is just displayed outwardly. Moreno and Mayer (2007) who talk about the methodology guideline and compose: "When that the learner chooses pertinent words and pictures from one fragment of the presentation, the following segment starts, along these lines stopping the time required for more profound handling".

Mousavi et al. (1995) tried for the methodology impact utilizing geometry directions. The specialists contended that if working memory restrictions were the reason for the split-consideration impact, then expanding working memory by introducing data to both visual and sound-related tactile modalities, rather than the visual frame, would be useful. The outcomes showed that an outwardly shown geometry outline, combined with proclamations introduced auditorily, improved learning contrasted with traditional visual-just presentations.

Tindall-Ford et al. (1997) additionally discovered proof of the methodology impact in investigations. His examination showed that when two wellsprings of data must be rationally incorporated, it is ideal to introduce the content in a sound-related shape unless the chart and material could be physically consolidated. In the review by Mayer, Dow, and Moreno (2003),

understudies saw inquiries concerning electric engines. Students could click different inquiries recorded on the screen to find a solution. The answers were displayed in two ways; sound portrayal and printed content. Students who got the sound portrayal tackled more issues from a resulting critical thinking test (Abkemeier, 2013). McNeill in 2004 led an examination intended to develop these discoveries by investigating the impacts of presentation methodology and repetition of verbal data on understudies' capacity to apply and review a verifiable request procedure.

Another investigational study to inspect the methodology impact in a learner-controlled condition was done by Wen-hung Chung carried out in 2006. The test material was a cardiovascular interactive media module that was utilized to test the principal impact. It comes about demonstrating that methodology impact was still present however not between the self-managed listening bunch and the self-text block perusing bunch. A post-contemplate study demonstrated members' distinctive reactions to the two modalities and their inclinations too.

The main conclusions are drawn from the previous research on dual modality effect are:

- All psychological scholars and numerous other instructive analysts acknowledge the design of data handling, including the ideas of a constrained limit of working memory.
- Ineffectively composed guidelines can force substantial working memory requests that unfavorably influence execution.
- The research proposes that more memory limit is accessible when double modalities are utilized, which guarantees that the presentation of pictures with sound-related writings prompts preferable learning results over the presentation of images with visual content.
- Educators ought to use instructing methodologies to guarantee that understudies are effectively building their insight. Other proposed thoughts originate from the extra research writing. A couple key discoveries and suggestions are to display the material that adjusts to the earlier information of the learner (inborn load), stay away from unnecessary and befuddling data (outer pressure), and invigorate forms that prompt reasonably productive and significant information (fitting burden).

## **Methodology**

### **Research design**

The research design of this study was experimental in nature. 'Pretest –Posttest control group design' was used.

### **Population**

The target population for this study was pre IX class female Arts students enrolled in all FG Public (Girl) Schools in Rawalpindi Cantt. There were 30 Girls schools in Rawalpindi region and, in these schools, approximately 900 Art students were getting education in the morning session. Hence the population size was about 900 girl students of pre IX class studying in 30 FG Girls schools located in Rawalpindi Cantt.

### **Sample**

Subjects were selected from the defined population in this study by using cluster sampling technique. FG Public School (Girls) Lalazar was selected as a cluster from other clusters of FG Public Schools (Girls) of Rawalpindi region. The sample consisted of 36 students of pre IX class studying at F.G Public School (Girls), Lalazar, who were divided into two groups of 18 students in each group by matching them on their pre test scores.

## **Instruments**

The data was collected through pre and posttests as per the requirements of this study. It was a true experimental study. The pretest and posttest control group design was used for conduction of study and collection of data.

Two types of tests, Pretest and Posttest were prepared for this study and their validity and reliability was ensured

Pretest is a way of obtaining information about group equivalence by taking pretreatment observations on the two groups and showing that they were similar at the start of the experiment. The post test is the judgment of the dependent variable after the treatment has been provided to the experimental group. The pretest in this study was used as a post test, only the arrangement of items was changed.

## **Reliability**

The reliability of the test of this study was checked through the Split-half method, by using product moment correlation technique. Firstly, items of the test were divided into two halves as odd and even items. Then by finding the correlation between the scores obtained on each half test, the reliability of the half test was calculated by Pearson correlation coefficient which was 0.63 and converted into the reliability coefficient of full test. It was found empirically that the test contained reliability i.e. +0.77 which was quite satisfactory.

## **Validity**

To check that the test measures which it purports to measure, a table of specification was constructed before starting the experiment in which due importance was given to the nature of objectives and selected content.

## **Procedure**

Following steps were taken for conducting this experiment:

1. The sample was administered as a pretest of the dependent variable on Chapter 2 of the science subject to see if the groups were essentially the same on the dependent variable.
2. Students were assigned to two groups i.e. the experimental and the control group by matching them on their pretest scores.
3. The group title was randomly assigned i.e. experimental and control group, by tossing a coin.
4. The treatment was provided to both the groups by the researcher herself, by taking five periods per week, of 35 minutes duration.
5. The researcher taught the same content to both groups in consecutive periods by altering the teaching sequence. On the first day, the control group was taught before the experimental group by single mode. Next day, the experimental group was taught through dual mode then the control group was taught in the next period by single mode. During the experiment, the same methodology was followed.
6. Treatment was provided to the experimental group through dual mode of presentation and to the control group by single mode of presentation. For the dual mode, flowcharts, diagrams, flashcards,

models and Power point presentations beside the textbooks were used. For a single mode of presentation, a lecture method was used.

**Data Analysis**

This part deals with analysis and interpretation of data. Tables displaying the analyzed data are drawn here. The analyzed data is interpreted below each table.

**Table 1: Mean and SD of pretest scores of the experimental group**

<i>N</i>	<i>Mean</i>	<i>SD</i>
18	11.55	2.9

As the entries in table 1 given above show, the average pretest score of the experimental group is 11.55 out of the maximum score of 30. The spread of score among the students in this group is 2.9. This indicates that the experimental group, as a whole, achieved low and the individual variation in the pretest scores among the students of this group was 2.9. Thus, they achieved low and didn't differ much in their individual achievement.

**Table 2: Mean and SD of pretest scores of the control group**

<b>N</b>	<b>Mean</b>	<b>SD</b>
18	11.5	3.05

As the entries in table 2 given above show, the average pretest score of the control group is also 11.5 out of the maximum score of 30. The spread of score, like the average score among the students in this group is also apparently the same i.e. 3.05. This indicates that the control group, as a whole, also achieved low and the individual variation among the students of this group was 3.05. They didn't differ much in their individual achievement.

Both groups, the experimental and the control group, achieved at equal level because the students were assigned to the experimental and control group by matching them on their pretest scores.

**Table 3: Significance of difference between the mean pre test scores of the experimental group and the control group**

<b>Group</b>	<b>N</b>	<b>Mean</b>	<b>SD</b>	<b>SE</b>	<b>T</b>	<b>P</b>
Experimental	18	11.55	2.9	0.9	0.06	
Control	18	11.5	3.05			>0.05

df =17 , t at 0.05=2.11

As the entries in the above table depict, the minor difference of 0.05 in the mean pre test scores of the experimental group and the control group suggests that the group were equal in their pretest achievement due to matching. The t-value turned out to be 0.06 which was smaller than critical value i.e. 2.11. This shows that two groups didn't differ significantly in their pre test achievement at 0.05 level of significance.

**Table 4: Mean and SD of post test scores of the experimental group**

<b>N</b>	<b>Mean</b>	<b>SD</b>
18	20.2	2.92

As the entries in table 3 given above show, the average pretest score of the experimental group is 20.2 out of the maximum score of 30. The spread of score among the students in this group is 2.92. Difference in mean values between Pre test and Post test of the experimental group indicates clear learning improvement. As a result, the stated mean difference can be attributed to treatment effects. Whereas the individual variation among the students of this group is 2.92. It means that they didn't differ much in their individual achievement.

**Table 5: Mean and SD of post test scores of the control group**

<b>N</b>	<b>Mean</b>	<b>SD</b>
18	17	3.62

As the entries in table 4 given above show, the average pretest score of the control group is 17 out of the maximum score of 30. The spread of score among the students in this group is 3.62. This indicates that the control group, as a whole, achieved low and the individual variation among the students of this group is 3.62. High value in SD i.e. 3.62 as compared to Pretest value which was 3.05, shows that there is more variation among students of the control group in their post test achievement.

**Table 6: Significance of difference between the mean post test scores of the experimental group and the control group**

<b>Group</b>	<b>N</b>	<b>Mean</b>	<b>SD</b>	<b>SE</b>	<b>T</b>	<b>P</b>
Experimental	18	20.2	2.82	1.04	3.138	
Control	18	17	3.62			<0.05

df =17 , t at 0.05=2.11

As the entries in the above table indicate, the apparent difference in the mean post test scores of the experimental group and the control group was 3.2. The t-value turned out to be 3.138, which is not only significant at 0.05 level of significance but also at 0.01 level of significance. This means that the difference in the average achievement of both the groups was highly significant indicating there-by that the method of teaching had a clear effect on the achievement of the experimental group. The null hypothesis of the study thus was rejected. The raw pretest and post test scores of experimental and control groups are given in appendices H and I respectively.

## **Results**

Following were the findings of this study:

1. The average pretest score of the experimental group was 11.55 out of 30 and the spread of scores 2.9 which indicate the existence of individual differences within the group. This indicates that the experimental group, as a whole, achieved low and the individual variation among the students of this group was 2.9 (As the entries in table 1 shows)
2. The average pretest score of the control group was also 11.5 out of the maximum score of 30. The spread of score among the students in this group was 3.05. This indicates that the control group, as a whole, achieved low and the individual variation among the students of this group was 3.05. Both groups, the experimental and the control group, achieved at equal level because the students were assigned to experimental and control group by matching them on their pretest scores. (As the entries in table 2 shows)

3. The average post-test score of the experimental group was 20.2 out of the maximum score of 30. The spread of score among the students in this group was 2.92. Difference in mean values between Pre test and Post test of the experimental group indicates clear improvement. Thus the said mean difference is attributable to the treatment effects. (As the entries in table 4 shows)

4. The average pretest score of the control group was 17 out of the maximum score of 30. The spread of score among the students in this group is 3.62. This indicates that the control group as a whole achieved low. (As the entries in table 5 indicates)

5. The minor difference of 0.05 in the mean pre test scores of experimental group and control group suggests the groups to be the same due to matching. The t-value turned out to be 0.06 which was smaller than critical value of 2.11, this shows that two groups didn't differ significantly at pre test stage at 0.05 level of significance. (As the entries in the table 3 depicts)

6. The apparent difference in the mean post test scores of the experimental group and the control group was 3.2. The t-value turned out to be 3.138. Which was not only significant at 0.05 level of significance but also at 0.01 level of significance. This means that the difference in the average achievement of both the groups was highly significant indicating thereby that the method of teaching had a clear effect on the achievement of the experimental group. The null hypothesis of the study was rejected. (As the entries in the table 6 indicates)

## **Conclusions**

In the light of findings of this study, following conclusions were drawn. The purpose of this experimental study was to investigate the effect of dual mode of presenting information on 9th grade students' achievement in the subject of General Science.

1. The average achievement of the experimental group and the control group did not differ before the treatment, both the groups being equal with respect to their previous knowledge in the subject of general science.

2. After giving the treatment of dual mode of teaching to the experimental group and single mode of teaching to the control group, it was found that the experimental group, on the average, did much better than the control group.

The research hypothesis was therefore supported, leading to the conclusion that using dual mode of teaching and learning (showing/seeing and telling/hearing), the 9th grade students, on the average, learnt the subject more than by using single modality of teaching and learning (showing/seeing or telling/hearing). Thus the prediction of the Cognitive load theory was supported in this study.

## **Discussion**

"A picture is worth a thousand words" People have since quite a while ago cited this announcement, regularly crediting it to an antiquated Chinese saying. New neuroscience and perception investigation now uncovers the looks of the science behind this old adage. Late innovative advances through Functional Magnetic Resonance Imaging examines affirm a double coding framework through which visuals and sound-related content information sources are handled in the working memory in discrete channels, showing the potential for synchronous expansion of learning. The main issue is that understudies utilizing a very much planned blend of visuals and content take in more than understudies utilizing a single method of showing data. The exploration demonstrates that understudies gain better and more from talked words and visual

pictures than from words alone. The intricacy of instructing and learning turns out to be progressively evident as the physiological, subjective, social, and enthusiastic parts of learning get to be distinctly known. Teachers are in a consistent look for more productive and viable approaches to propel understudy learning. In general, multi modal learning has been shown to be more effective than traditional, uni modal learning. Adding visuals to verbal and auditory learning can result in significant gains in basic and higher-order learning.

Numerous studies in the field of learning have confirmed the modality effect of the Information load theory. It claims that presentation of pictures with auditory texts leads to better learning outcomes than the presentation of pictures with visual text. Therefore, this study was conducted to test the effectiveness of dual modality on a student's achievement in the subject of general science.. The findings of the experiment reported in the present study are in line with Sweller (1988) PAVIO (1990) Mousavi, Low Sweller (1995) VanMerriënboer & Paas (1998), Mayer & Moreno(1998) ,Cowan(2000) ,Feinberg Murphy(2000), Heeb(2001) Kirschner (2002), Passet-al (2003), Tabbers, Martens & Van Merriënboer (2004).The latest research studies on dual modality such as by McNeill (2004), Zolna (2005), Chung (2006), Rebetez (2006) and Reynold (2012) also found that dual mode of presenting information enhanced learning outcomes. However, Mayer et al Harskamp et al. (2007) studied the modality effect in a more realistic situation.

Most of the above mentioned studies indicated the positive effect of dual mode of presenting information on learner's understanding and achievement. As a result, multiple research in the field of learning has supported the modality principle, which states that displaying pictures with verbal description improves learning outcomes but there are also a few studies with contradictory research findings. In the present study, comparison of pretest scores of both the experimental and control groups by applying statistical analysis reflected that there existed no real difference between the two groups, both the groups being almost equal with respect to basic scientific knowledge due to matching the groups on their pretest scores. The experimental group performed much better than the control group on the post test. The rationale behind this finding is that information was presented through both the auditory and visual channels of the working memory system without overloading either channel. This reduced the cognitive load in working memory allowing the learner to make necessary connections between the visual depiction of the process and the corresponding verbal explanation. So, it enhanced student's retention and supported the concept of dual modality.

Taken all things considered, the aftereffects of this review have some hypothetical and pragmatic ramifications. Hypothetically, the principle outline of this review affirmed the methodology impact and its basic hypothesis, the psychological load hypothesis. Much more profound, it adds to the multi-segment structure of working memory which incorporates the sound-managing subsystem and Visuo - spatial subsystem

Despite the fact that students of the experimental group outscored the students of the control group after the experiment, this result could not be generalized to the population of this study. The gain of average score in the experimental group could be attributable to a variety of variables such as pupil's cognitive level, their background, conceptual level, willingness to study science, maturation level, physical and environmental conditions, motivation of both teacher and the taught and, above all, the size of class that might have influenced the study results. Moreover, the novel use of diagrams, pictures and models in teaching methods might have created interest among the students of the experimental group where they were free to learn at their own pace. Hence more research is required to test the dual modality effect of the cognitive load theory in system controlled realistic situations.

Although a kind of true experimental design known as pretest post test control group design was used in this study, other kinds of true experimental designs such as post test only control group design and Solomon three or four- group design are tried out in order to obtain more authentic and reliable results. Hence the present study could be replicated by using alternative research methods.

The sample size of this study also prevents the generalization of its results because the sample size was small. Larger samples from a wider population could have made the results more accurate and generalizable. Shortage of time duration in which the experiment was conducted might be another factor that could have the study results doubtful.

In short, there were a number of potential weaknesses of this study that might have reduced the accuracy of its results, to be overcome in future research on this theoretical framework. Nonetheless, this study perhaps is one of the pioneer studies in Pakistan on a modern theory of learning that has a lot of applicability in improving the traditional teaching scenario in the country.

## **Recommendations**

The current study was intended to contribute to the emerging body of literature on the use of dual modality in presenting information. There are several recommendations stemming from this study which are as follow:

1. As indicated by the results of this study, dual mode of presenting information appears to be more effective than single mode for processing new information in the working memory because dual mode of teaching reduces overloading it. Therefore, teachers are advised to use dual mode instead of single mode during teaching to enhance student learning and achievement.
2. The education department may arrange touring teams of qualified and trained master trainers to deliver model lessons to the science teachers for practically demonstrating the dual mode (speech and diagrams) for presenting the new teaching material.
3. The school heads are directed to spend the allocated money regularly out of the school funds for the purchase of AV aids. The use of dual mode of presenting the new material during general science secondary classes be personally supervised and monitored by them.
4. Teachers must be trained in the use of dual modality presentations so that they could be able to use memory enhancing methods not only in class rooms but also in the curriculum designing process.
5. The skill of using dual modality can be ensured in pre service teacher education programme while teaching the subject of sciences during short term and long term teaching practice.
6. Students may be stimulated to collect pictures, charts, maps, flash cards, videos, models and other low cost AV aids material .
7. As this study was conducted at secondary level, future experimental studies on this topic will also be conducted at primary, higher secondary and tertiary levels of education in order to generalize the results to other levels.

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