CAN GRAPHIC ORGANISERS ENHANCE SCIENCE ACHIEVEMENT IN SCHOOL STUDENTS?

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Graphic organisers are teaching and learning tools that show the organisation of concepts as well as relationships between them in visual formats. The objective of the study was to find out the effectiveness of graphic organisers on science achievement. In this study, three groups pre-post test experimental design was adopted. Ten mini-lessons on the graphic organiser were conducted for the experimental group for 12 days. Science achievement test with four multiple-choice options was used. A total of 75 students was selected and divided into three groups of 25 each, viz., control, module, and experimental based on the group mean of the pretest. The t value calculated between the pre-test and post-test mean of the module group was found to be significant (5.97) and the effect size was found to be very large (1.716). The t value calculated between the pre-test and post-test mean of the experimental group was found to be significant (21.64) and the effect size was found to be huge (4.866). Today, most of the concepts are overlapping and need multiple perspectives to understand but through graphic organisers, students can prepare visual representations that can be used for remembering, clarifying, and easily relating to multiple aspects of the concepts.

Keywords: Learning strategy, visual representations, biology learning, Cohen's d effect size, experimental design

Introduction

In today's educational scenario, getting a job or cracking entrance exams is not as easy because the competition has become too high. The students have to learn a vast number of concepts. The teachers in that situation must orient students towards learning strategies to learn fast, accurately, and remember for a more extended period. One such way is through the usage of graphic organisers in learning. According to Ausubel's theory, meaningful learning occurs when an individual's existing knowledge interacts with new information in a non-arbitrary way. Ausubel (1960) found that meaningful learning of verbal material could be enhanced by using an advance organiser. An advance organiser is a tool that is presented prior to the material to be learned and that helps learners organise and interpret new incoming information. Advance organisers in cognitive instruction promote the learning and retention of new information. It is vital to link old information with something new. They help students recognise that the topic they are beginning to learn is not totally new and provide teaching explanations that include concepts. This study aims to develop a self-learning environment and retention of concepts using graphic organisers. In this study, the learners must be aware of graphic organisers. The learners should know the uses of graphic organisers; in turn, they should choose the correct

graphic organisers for the concepts, prepare graphic organisers for the given concept in science, learn science concepts through prepared graphic organisers and score well on the achievement tests.

Graphic organisers will help in learning as well as retention of science concepts. A graphic organiser is a strategy for science instruction that teachers can use to help students record information from direct observation as well as from reading to create a descriptive model of an organism or a phenomenon. Advance organisers have also been presented graphically. They are also called graphic advance organisers in some research. Graphic organisers are teaching and learning tools that show the organisation of concepts as well as relationships between them in a visual format. While advance organisers are being used at the beginning of the lesson, graphic organisers can be used in any process of the lesson with different aims. They can be used as a teaching tool throughout a lesson or for review at a later time. Being visual is so crucial in graphic organisers, but advance organisers can be visual or solely prose. Graphic organisers can help students organise their knowledge and encourage them to become actively engaged during the discussion of the topic and its concepts. Moreover, students will find it helpful in many competitive exams for jobs, entrance exams for higher education, etc. Therefore, using the graphic organiser can assist in making the topics more understandable for the students and retain concepts for a more extended period.

The prevalent theory behind the use of graphic organisers comes from the cognitive psychology literature. Based upon research by Ausubel (1963, 1968) and Ausubel et al. (1978), cognitive psychology is the learning that takes place by the assimilation of new concepts and propositions into existing concepts and propositional frameworks. Ausubel's theory of meaningful versus rote learning suggested that meaningful learning intentionally attempts to integrate new information, uses a more extensive network, and creates more means of recovery. Graphic organisers were first reported by David Ausubel in 1969 in his glossary; he states that graphic organisers are like a bridge that links the gap between the learner's prior knowledge and what they have to learn (Culbert et al., 1998).

Graphic organisers are an attribute of organising thoughts. The users may use graphic organisers to visually depict an idea through sequences or charts. Graphic organisers are the visual representation of knowledge that structures information by arranging important aspects of a concept or topic into a pattern using labels. Their primary function is to help present information in concise ways that highlight the organisation and relationships of concepts. Simply stated, a graphic organiser is a "visual representation of knowledge" regarding a certain concept (Bromley, DeVitis, and Modlo, 1999). More specifically, graphic organisers are arranged in a way that best shows the interrelatedness of pieces of information presented (Horton, Lovitt, and Bergerud, 1990). Graphic organisers are also known as key visuals, cognitive organisers, or advance organisers that are formatted for organising information and ideas graphically or visually. Just as cooperative learning groups make student thinking audible, graphic organisers make student thinking visible. Students can use graphic organisers to generate ideas, record and reorganise information, and see

relationships. They demonstrate not only what students are thinking but also how they think as they work through learning tasks. Examples of graphic organisers include tree charts, fishbone charts, flow charts, T-charts, Venn diagrams, K–W–L charts, idea builders, and mind maps.

Graphic organisers are visual depictions that resemble networks and allow students to add or modify their background knowledge by seeing the connections and contradictions between existing knowledge and new information. Graphic organisers serve as mental tools (Vygotsky, 1962) to help the students understand and retain important information and relationships. Graphic organisers provide an optional way of depicting knowledge and understanding (Sorenson, 1991), so it is particularly beneficial for students who have difficulty with expressing relationships among parts of science concepts in the written word. Students who use graphic organisers in the classroom develop their ability to use them independently as study tools for note-taking, planning, presentation, and review (Dunston, 1992).

Tandog and Bucayong (2019) reported that the integration of effective study techniques could still be a relevant education research topic if we are to consider the changing demand for skills brought about by technological advancements. Thus, graphic organiser as a teaching tool was developed and implemented to promote conceptual understanding in the solution processes of algorithmic related topics in Physical Science. Iofciu, Miron and Antohe (2011), in a study entitled "Graphic Organiser for the constructivist approach of advanced science concepts." The study revealed that retaining of information in extraordinary development of technical applications is a real challenge for science teachers and they wish to use graphic organisers to their interested students for grasping advanced science concepts. Fisher, Frey and Williams (2002) have observed positive reactions among students to the use of graphic organisers.

Banikowski and Mehring (1999) highlighted that Teachers must introduce the use of a new graphic organiser to ensure its effectiveness in the classroom. Consistency across subject areas is another important element that ensures successful independent student practice of organising techniques in the classroom. The review of related literature demonstrates that graphical visualisation provides a framework to systematise ideas, facts, and concepts that promotes the development of higher-order thinking skills and facilitate effective student learning.

Objective of the study

To find out the effectiveness of graphic organisers on science achievement.

Hypotheses of the study

The following hypotheses were formulated in this research

1. There is no significant mean difference in pre-test scores of the control group, module group, and experimental group in science achievement.
2. There is a significant mean difference in post-test scores of the control group, module group, and experimental group in science achievement.

There is a significant mean difference between the pre-test and post-test scores

of the control group, module group, and experimental groups in science achievement.

Experimental Research Design

To study the effectiveness of applying graphic organisers to the achievement of science, an experimental method was employed. Three groups, namely control, module and experimental groups were taken, and a pre-test was administered, followed by providing a module to the module group and treatment with a module to the experimental group, and a post-test was given to find out the effect of the module and treatment. In this study, the investigator adopted three groups — pre-test-post-test experimental design. The investigator had the study for a period of one week for the preparatory programme and 12 days for the intervention programme from January to March. As the researcher felt the urgent need for the improvement of science learning among elementary school students, the investigator prepared the module on graphic organisers that will enhance science learning among students.

Sample

Based on the group mean of the pre-test, three groups were formed, namely, the control, module, and experimental groups involving 25 students each. The study sample was the two sections of Class VIII students of Government High School, Thippirajapuram of Kumbakonam block in Thanjavur District of Tamil Nadu. The sample of the study is shown in Table 1.

Table 1
Sample groups classified based on the pre-test

S. No.	Sample groups	N	Graphic Organiser Module Provided	Intervention Given
1.	Control group	25	No	No
2.	Module group	25	Yes	No
3.	Experimental group	25	Yes	Yes

Delimitations of the study

1. The study was restricted to both sections of Class VIII students of Government high school of Tamil Nadu Thippirajapuram from the Kumbakonam block of Thanjavur District.
2. Graphic organisers are limited to 10 in number.
3. The study only concerned 75 students in Class VIII students, which were classified into three groups.
4. The focus is to apply graphic organisers shown in the given module and not create a new one.
5. Only concepts given in the Class VIII term three Tamil Nadu Government science textbooks are selected for the study.
6. The intervention programme was carried out for 12 working days.

Development and validation of science achievement test

To find out the effect of the treatment, the investigator has framed a pre-test tool and a post-test tool in Tamil. Before administering the pre-test tool, it was given to the subject experts to identify the content validity, and the reliability was also established from Cronbach's alpha. A pilot study has been conducted among 33 students of other schools Government Higher Secondary School-Aduthurai, Thiruvidaimarudur, Thanjavur district and Govt. Hr. Sec School Chettimandapam, Kumbakonam, Thanjavur district, where the intervention was not planned. Based on the students' performance in the pilot study, item analysis was done, and the pre-test tool was developed. Initially, there were 60 items, but finally, 42 test items were selected for the study based on item analysis. Finally, Cronbach's alpha was found to be 0.73, and thus the achievement test was considered reliable.

Intervention

The graphic organiser module developed by the investigator was administered in the treatment programme. The prepared module was given to the module and experimental groups except for the control group. One biology lesson was discussed and made to complete the graphic organisers for the experimental group only. The mini-lessons using graphic organisers were: Scanning, Science Vocabulary, Compare and Contrast, TimeLine, 5W1H, Science Activity, Flow Chart, Tree Chart, Concept Map, and Fish-Bone as shown in Appendix 1 were implemented for the experimental group and insisted on completing all the ten graphic organisers for one lesson (No. 7), Crop Production and Management (Biology) as shown in appendix 2. One lesson each for Physics (Unit 1 Sound) and Chemistry (Unit 6 Chemistry in Everyday Life) was chosen and given a one-week duration to prepare the graphic organisers introduced by the investigator. The same three lessons were intimated to all three groups as the portion for the post-test.

Results

After the planned intervention towards using graphic organisers in the science concepts, the post-test was conducted. The results were analysed using SPSS version 21 and were tabulated and interpreted below:

Table 2

Mean, Standard Deviation (SD), and t value of the pre-test scores in science achievement based on groups

Groups	Mean	SD	t value	df	t sig.
Control Group Pre-test	11.88	2.60	0.14	24	0.89
Module Group Pre-test	11.76	2.68			
Module Group Pre-test	11.76	2.68	0.10	24	0.92
Experimental Group Pre-test	11.68	3.12			
Control Group Pre-test	11.88	2.60	0.26	24	0.79
Experimental Group Pre-test	11.68	3.12			

Table 2 shows that there is no significant mean difference between pre-tests of the control and module group, module and experimental group, and control and experimental group.

From Table 3, it can be inferred that the module group (15.84) scored higher than the control group (12.24) in the post-test, as the t value was determined to be 5.49, which was significant at a 0.01 level. The experimental group (26.69) scored higher than the module group (15.84) in the post-test, where the t value was estimated as 18.17, which was significant at a 0.01 level. The experimental group (26.69) scored higher than the control group (12.24) in the post-test, where the t value was estimated as 17.01, which was significant at a 0.01 level.

A perusal of Table 4 shows that the t-value calculated between the mean scores of the pre-test and post-test of the control group is found to be 0.54, which is not significant even at a 0.05 level; thus, there is no need to calculate the effect size. The t value calculated between the mean scores of the pre-test and post-test of the module group is found to be 5.97, which is significant at a 0.01 level. The post-test mean (15.84) is higher

Table 3
Mean, Standard Deviation (S.D.), and t value of the post-test scores in science achievement based on groups

Groups	Mean	S.D.	t value	df	t sig.
Control Group Post-test	12.24	2.54	5.49	24	0.00
Module Group Post-test	15.84	2.03			
Module Group Post-test	15.84	2.03	18.17	24	0.00
Experimental Post-test	26.96	3.16			
Control Group Post-test	12.24	2.54	17.01	24	0.00
Experimental Group Post-test	26.96	3.16			

Table 4
Mean, S.D., t value, and correlation of the pre-test and post-test scores in science achievement based on groups

Groups	Test	Mean	S.D.	t value	df	t sig.	Cohen's d
Control Group (25)	Pre-test	11.88	2.60	0.54	24	0.60	–
	Post-test	12.24	2.54				
Module Group (25)	Pre-test	11.76	2.68	5.97	24	0.00	1.716
	Post-test	15.84	2.03				
Experimental Group (25)	Pre-test	11.68	3.12	21.64	24	0.00	4.866
	Post-test	26.96	3.16				

than the pre-test (11.76). The magnitude of the difference between the pre-test and post-test mean is estimated by Cohen's d (1.716), which is found to be very large (Sawilowsky, 2009). The t-value calculated between the mean scores of the experimental group's pre-test and post-test is 21.64, which is significant at a 0.01 level. The post-test mean (26.96) is higher than the pre-test (11.68). The magnitude of the difference between the pre-test and post-test mean is estimated through Cohen's d (4.866), which is found to be huge (Sawilowsky, 2009). Therefore, it can be inferred that the intervention of graphic organisers had a significant effect on students' achievement in science. The line graph of mean scores of pre-test and post-test in the control, module, and experimental group are shown in Fig. 1.

Educational implications

The graphic organiser is a self-learning strategy whereby students can learn independently with little guidance from the teacher. Through this, students will grasp the concepts and understand them deeply. Today, most of the concepts are overlapping and need multiple perspectives to understand. However, through the graphic organiser, students can prepare visual representations that can be used for remembering, clarifying, and easily relating to multiple aspects of the concepts they learn. The teachers just need to monitor the preparation of the visual forms by students; they have to simply monitor and guide the students wherever needed. However, once the students learn and apply graphic organisers in their academics, they can be helpful throughout their life. Many

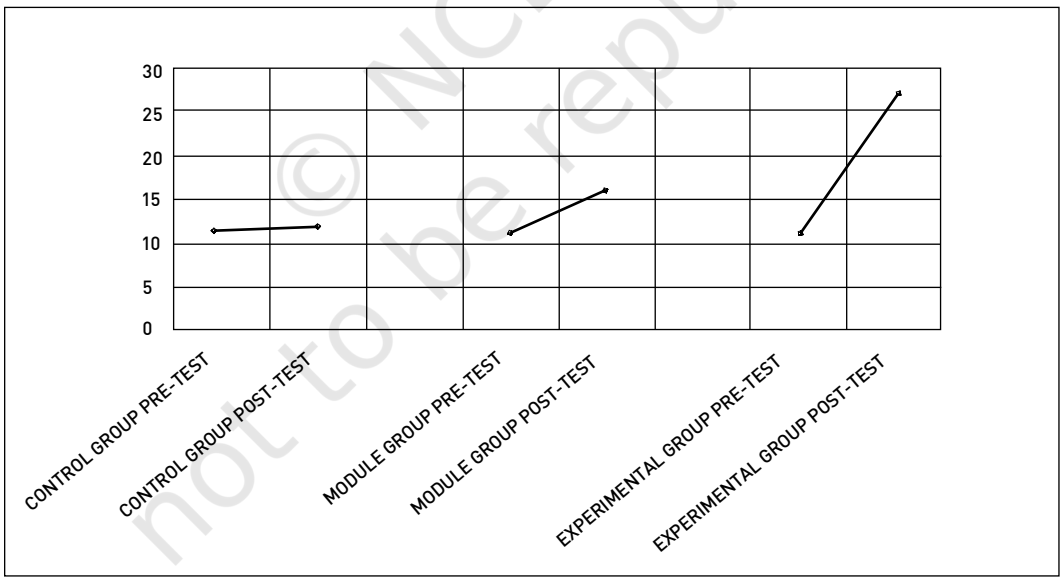

Fig. 1. Line graph showing mean scores of pre-test and post-test in the control, module, and experimental group

formats of graphic organisers are available on the internet; the teachers can adapt them according to their needs and modify them according to their concepts and students' learning levels. This graphic organiser makes students learn concepts and remember them for a more extended period. Graphic organisers can be kept for a long time for any future exams and even it will be helpful for competitive exams. Even though we have efficient modules/ books/ booklets, still academicians/ teachers must use graphic organisers efficiently for better student performance in academics.

Conclusion

This research takes the positive path in accordance with the review of related literature discussed. Graphic organisers are very effective self-learning strategies that could be used with little guidance from the teacher; the students can learn more profound concepts and remember them for a more extended period. Academicians should prepare and validate a standard module through SCERT or NCERT so that teachers can use that module in their teaching-learning process. Central and State governments should take steps to give orientation on graphic organisers to teachers. Teachers should implement these strategies in their teaching-learning process. Graphic organisers can be prepared for other subjects in other classes, and this would be helpful for competitive examinations while they are in the school itself. Teachers must implement these graphic organisers in their teaching-learning and feel the difference. This could even lessen their burden of teaching and make students remember and retain many complex or overlapping concepts for a more extended period.

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Appendix 1: Graphic Organisers as per module prepared by the investigator

1. Scanning the Chapter

Chapter: _____

I. Heading and Sub-heading

1	Heading
1.1	Sub-heading
1.2	Sub-heading
1.2.1	Sub (Sub-heading)

II. Science Activity

S. No.	Page No.	Activity heading	Do you know?	Whether you can do

III. Tables

S. No.	Description of the table

IV. Figures

Fig. No	Description of the figure	Do you know

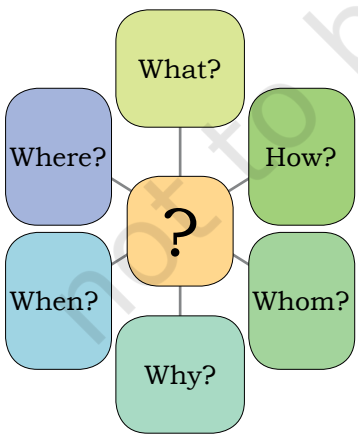
V. "Do you known?" Total numbers given in that chapter:_____

VI. "More to Know" Total numbers given in that chapter: _____

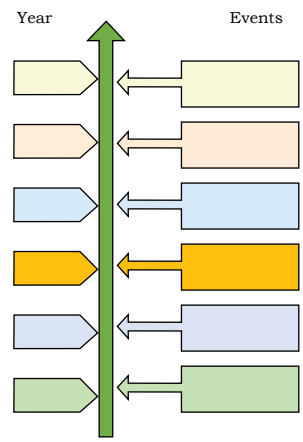
2. Science Vocabulary

S. No.	Page No.	Word	Can I define it?	What is it related to?	Definition	Whether given in book back glossary?

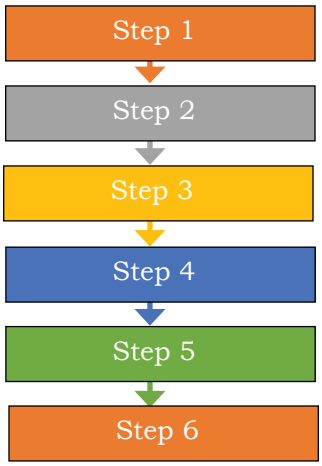
3. 5W1H



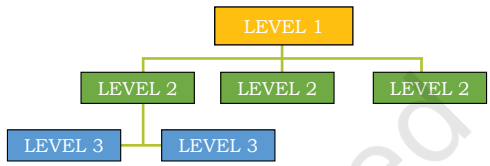
4. Time Line Chart



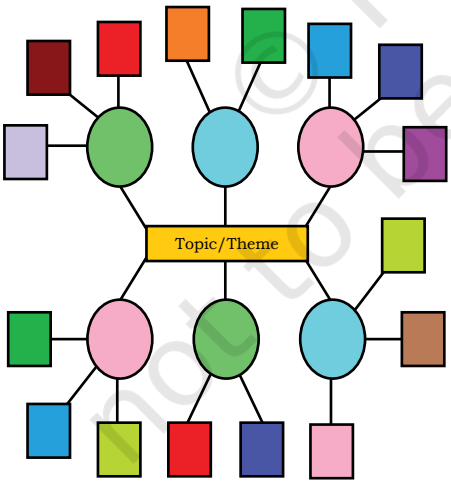
5. Flow Chart (Process)



6. Tree Chart



7. Concept Map



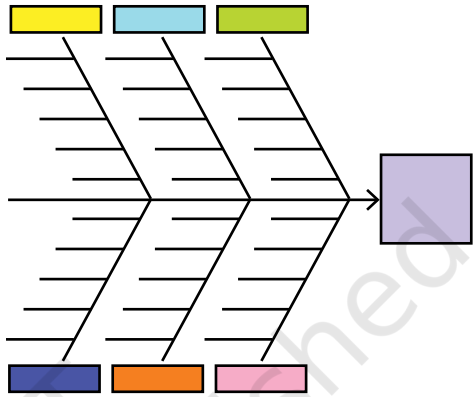
8. Science Activity

Activity title:	
Process: 1 2 3 4 5 6	**Materials Required:** 1 2 3 4 5
Questions: 1 2 3 4 5	**Answers:** 1 2 3 4 5
Inference/ Conclusion/ Summary of the activity:	

9. Compare and Contrast

S. No.	Subject 1	Subject 2
1		
2		
3		

10. Fish Bone



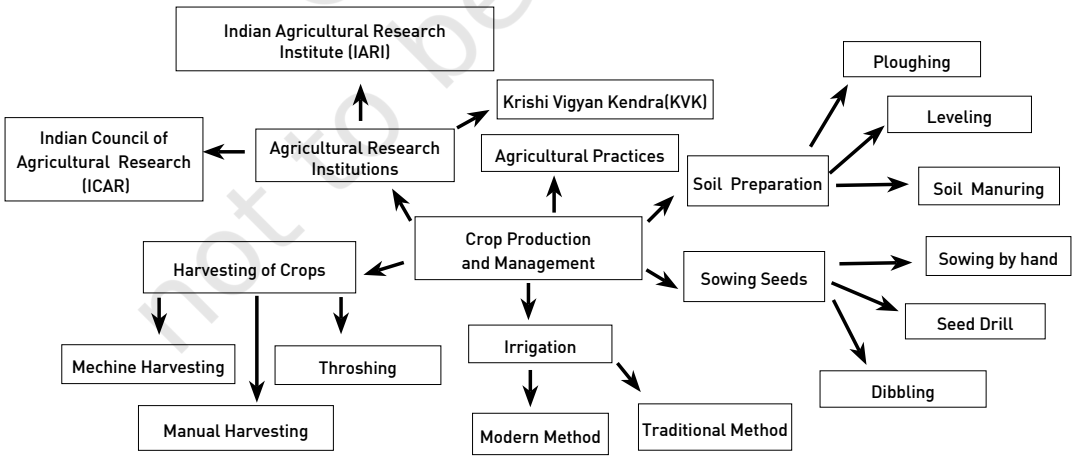
1. Scanning 2. Science Vocabulary 3. 5W1H 4. Time Line 5. Flow Chart
6. Tree Chart 7. Concept Map 8. Science Activity 9. Compare and Contrast, and
10. Fish-Bone

Appendix 2: Sample Graphic Organisers prepared by experimental group students as per module, and the instruction is given by the investigator

Vocabulary

S. No.	Page. No.	Words	You Know	Related	Meaning	Book back
1.	90	Basal Manuring	✓	Irrigation	Manuring means adding manure to the Soil	×
2.	90	Ploughing	✓	Soil enrichment	The process of loosing and turning at the Soil	✓
3.	93	Sprinkler Irrigation	✓	Proper Irrigation System to Plants	Method of applying irrigation water which is similar to natural rainfall	✓
4.	97	Mono-Culture	✓	Single pattern Crop Plantation	Planting of the same crop in the same field year after year	✓
5.	91	Dibbling	✓	Sowing in the Seed	Placement as seed material in a sarrow, pit or hole at predeter spacing mined	✓

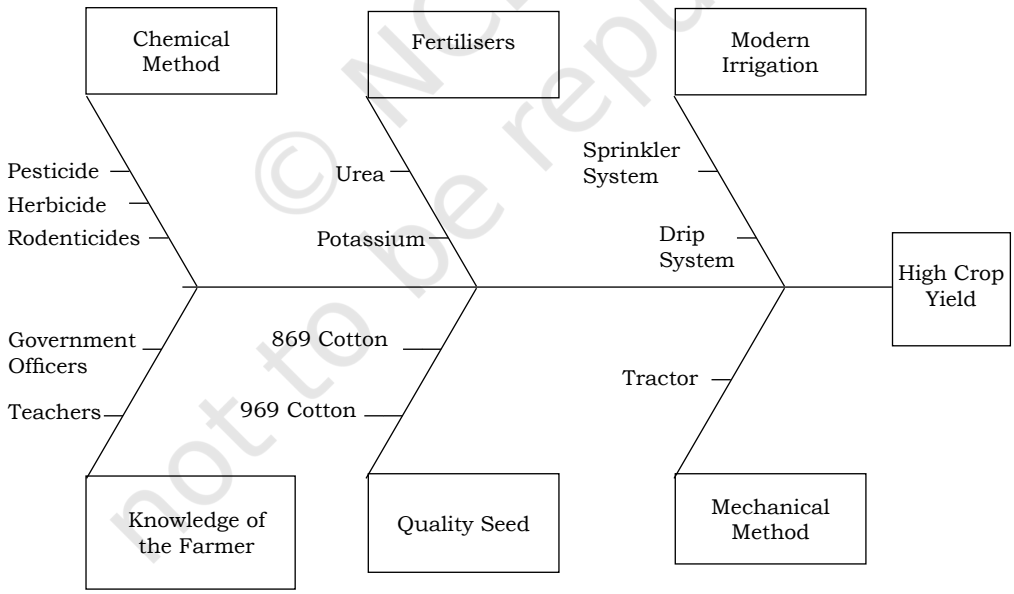
Concept Map



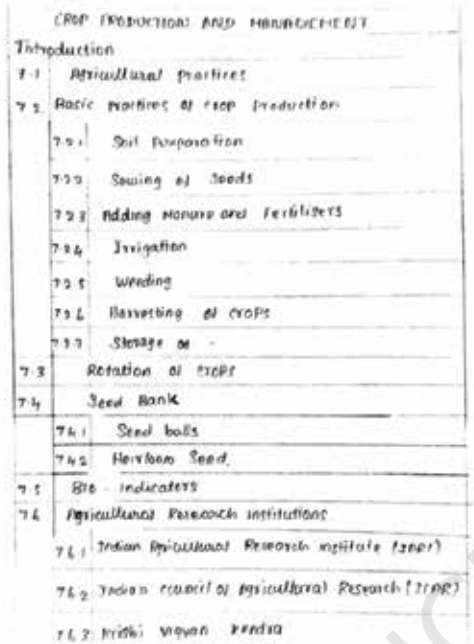
Compare and Contrast

***Kharid* Crops**	***Rabi* Crops**	***Zaid* Crops**
The crops which are sown in the rainy season are called *kharid* crops	The crops grown in winter season are called *rabi* crops	The crops which are grown in summer season are called zaid crops
Paddy, Maize, Soyabeen, groundnut and cotton.	Wheat, gram, ea, mustard, linseed	Watermelon cucumber.

Fish Bone



Scanning


CROP PRODUCTION AND MANAGEMENT

Introduction

7.1 Agricultural practices

7.2 Basic practices of crop production

7.2.1 Soil preparation

7.2.2 Sowing of seeds

7.2.3 Adding manure and fertilizers

7.2.4 Irrigation

7.2.5 Weeding

7.2.6 Harvesting of crops

7.2.7 Storage of

7.3 Rotation of crops

7.4 Seed Bank

7.4.1 Seed balls

7.4.2 Heirloom Seed

7.5 Bio - indicators

7.6 Agricultural Research institutions

7.6.1 Indian Agricultural Research Institute (IARI)

7.6.2 Indian council of Agricultural Research (ICAR)

7.6.3 Krishi Vigyan Kendra

Science Activity

Activity	Required Things
Set up a compost pit within your school compound. Put all the organic wastes like food waste and plant leaf in your school campus, cover it with soil. Wait for three weeks and then you can use this as manure for the plants in your school.	1. Collected food waste 2. plant leaf 3. Crowbar

Questions	Answers
i) What constitutes organic from wastes?	Collecting food waste plants leaf.
ii) organic from wastes should be cover with?	It should be covered with soil.
iii) After how many months later does organic farm waste should be used.	Three months
iv) How does organic farm waste can be used for plants.	As fertilizer.
v) where does the organic farm waste be used for plants.	Agriculture land open spaces, and schools.

Tree Chart