A COMPARATIVE STUDY OF FLIPPED CLASSROOM AND LECTURE METHOD ON PERFORMANCE OF SCIENCE STUDENTS AT SECONDARY LEVEL

THESIS

SUBMITTED FOR THE AWARD OF THE DEGREE OF

Doctor of Philosophy
In
Education

BY

SABIHA NAAZ

ENROLLMENT: A171085 (17PHED001DB)

UNDER THE SUPERVISION OF

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(PRINCIPAL – MANUU, COLLEGE OF TEACHER EDUCATION)

COLLEGE OF TEACHER EDUCATION, DARBHANGA

SCHOOL OF EDUCATION & TRAINNING

MAULANA AZAD NATIONAL URDU UNIVERSITY

Hyderabad-500032, INDIA

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A COMPARATIVE STUDY OF FLIPPED CLASSROOM AND LECTURE METHOD ON PERFORMANCE OF SCIENCE STUDENTS AT SECONDARY LEVEL

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LIST OF ABBREVIATIONS

ADDIE	Analysis, Design, Development, Implementation, Evaluation
AISTS	All India Seminar on Teaching Science
ANCOVA	Analysis of Covariance
ANOVA	Analysis of Variance
ATM	Achievement test in Mathematics
ATP	Adeno Triphosphate
B. ED	Bachelor of Education
CA	Cognitive Approach
CFI	Comparative Fit Index
CLS	Constructivist Learning Strategy
CoI	Community of Inquiry
DIKSHA	Digital Infrastructure for knowledge Sharing
ELF	English as a Foreign Language
FC MODEL	Flipped Classroom Model
FC-PBL	Flipped Classroom and Problem Based Learning

List of Abbreviations

FLN	Flipped Learning Network
GRI	Adjusted Goodness of Fit Index
HSTP	Hoshangabad Science Training Project
ICE	International Commission on Education
IFI	Incremental Fit Index
IPSC	Indian Parliamentary and Scientific Committee
I.Q	Intelligence Quotient
NCERT	National Council of Educational Research and Training
NCF	National Curriculum Framework
NEP	National Education Policy
NISHTHA	National Initiative for School Heads' and Teachers' Holistic Advancement
NKC	National Knowledge Commission
NPE	National Policy of Education
NRC (1996)	National Research Council (Washington)
NSES	National Science Education Standards
NSPR	National Scientific Policy Resolution

List of Abbreviations

NSSE	National Society of Study of Education
NSTA	National Science Teaching Association
RAMSEA	Root Mean Square Error of Approximation
SCERT	State Council of Educational Research and Training
S. D	Standard Deviation
SES	Socio- Economic Status
SPSS	Statistical Package for Social Sciences
SRL	Self-Regulated Learning
STEM	Science Technology Engineering Mathematics
TFC	Traditional Flipped Classroom
TNTEU	Tamil Nādu Teacher Education University
UNESCO	United Nations Educational, Scientific and Cultural Organization

A Comparative Study of Flipped Classroom and Lecture Method on Performance of Science Students at Secondary Level

ABSTRACT

Introduction

Challenges of the global world demand wide access and improved quality of school education. It cannot be met without using the modern and proper teaching methods in teaching learning process in school setting. Using innovative and best teaching methods to educate our future citizen to make a more success and good citizen. The national education policy (2019) focuses on online learning as an alternative to regular classroom interaction between teachers and students. It's a spotlight on the classroom setting. The establishment of the royal society in 1664 is a landmark in the history of science education. In the 21st century, science becomes an immense part of our life. At this time, it is a need of our society to develop the field of science & technology. Our government, policies & scheme related to education should focus on science education & teaching. Education Commission (1964-1966) stated, "that in a world based on science and technology it is education that determines the level of prosperity, welfare, and security of the people." Science helps us to understand motion, the evolution of life, chemical constituent, human physiology, plant physiology etc. According to National Curriculum Framework (NCF), 2005 science teaching means learning the facts and principles of science and its applications consistent with the stage of cognitive development. The national science teaching association (NSTA) recommends that the science education community support 21st-century skills consistent with best practices across a science education system, including curriculum, pedagogy, science teacher preparation, and teacher professional development (NRC 1996). ***National Science Education Standards*** (1996) are designed to guide our nation toward a scientifically literate society. The immense scope of science is taught by various methods according to age level, grade level and nature of content. Like Lecture method, Heuristic method, Discussion method, Experimental method, Project method, Lecture cum demonstration method,

Laboratory method, Cooperative learning method and so on. Lecture method is a teacher centered and traditional method. It is an oral presentation, teacher talks and explains facts, principles and wishes the students to understand, listen and taking notes. According to Bligh (1972), a lecture is a more or less uninterrupted talk from a teacher. Percival and Ellington (1988) who state that a lecture is 'a didactic instructional method, involving one- way communication from the active presenter to the more or less passive audience'. The idea of flipped classroom emerged in 1993 by researcher Alison King called "From sage on the stage to guide on the side" while the work did not express call for the use of "flipping" classroom. It used class time to give meaning and information to students learn. For this assertion, King's work is often considered the foundation for flipped classroom model. The phrase 'flipped learning' come into general use in the early mid 2000s when it was popularized by Chemistry teachers Jon Bergman and Aaron Sams (Bergman & Sams 2012). Flipped classroom is a "pedagogical approach in which direct instruction moves from the group learning space to the individual learning space, and the resulting group space is transformed into a dynamic, interactive learning environment where the educators' guides students as they apply concepts and engage creativity in the subject matter" (the Flipped Learning Network 2014).

Knowledge Gap

There was enough evidence of knowledge gap regarding school education with respect to these variables and covariables. Most of the studies designed with one type of school either government or private. If there were some studies taken both type of school government and private, though paired methods of teaching flipped classroom and lecture method was not target with. This study in the field of school education both government and private school is of high significant. Its finding would contribute fresh insight to enhance the quality of school education, increase the student-centered approach and learning with own pace. Present study will bridge the knowledge gap of ongoing trend of researches. It enables teacher to overcome with the dilemmatic perception of science teaching, anxiety and fear of science education from the student's mind. Stakeholders know about the problem of pedagogy of science teaching which is run in school. Know the facts of flipped classroom and lecture method and its

prose and cones. Help the teacher by training them with new methods of teaching and update them with new concepts emerging in teaching learning process.

Rationale of the Study

Hoshangabad Science Training Project (HSTP) (1972) was very first program which was started in 1972 by Kishore Bharat & friends Rural Centre, HSTP focus on improving science education from class 6 to 8. It involves learning by discovery through activities & from the environment. It emphasizes the process of science promoting scientific temper & making the child a confident lifelong self-learner and creator of knowledge. There are very few studies found in India regarding flipped classroom and its effect especially in science teaching. The result of study is expected that student centered methods will be better than teacher center. It will identify the real and logical effectiveness of flipped classroom and teaching learning material on science performance. There is lack of records of empirical evidence related to flipped classroom used in pedagogical practices especially secondary level in general, while in particular teaching of science need to be focused in this regard. Some certain reasons and situation prompted the researcher to select the area to study. Proposed study will give the logical evidence of the gap between lecture and flipped classroom. Findings of the study will ensure the problem of lecture method in science teaching at school level. Results of the study will promote the science teaching through the use of learning material and students learning through their own pace. The study pursues the following questions: -

i) Does flipped classroom effects the science achievement?
ii) Does the flipped classroom effect the scientific attitude?
iii) Does the flipped classroom effect the creative thinking skill?

Title of study

The problem under investigation was entitled as **"A comparative study of flipped classroom and lecture method on performance of science students at secondary level".**

Objectives of the Study

Accordingly, the experimental study was designed and conducted to achieve the following specific objectives: -

1) To compare the effect of flipped classroom and lecture method in terms of science teaching at secondary level students on-
    a) Science Achievement
    b) Scientific Attitude
    c) Creative thinking
2) To compare the effect of flipped classroom and lecture method in terms of science teaching on science achievement of-
        a) Govt. Secondary level students.
        b) Private Secondary level students
3) To compare the effect of flipped classroom and lecture method in terms of science teaching on a scientific attitude of-
    a) Govt. Secondary level students.
    b) Private Secondary level students
4) To compare the effect of flipped classroom and lecture method in terms of science teaching on creative thinking of-
    a) Govt. Secondary level students.
    b) Private Secondary level students
5) To compare the effect of flipped classroom and lecture method on science achievement of-
    a) Secondary level male students
    b) Secondary level female students
6) To compare the effect of flipped classroom and lecture method on a scientific attitude of-
    a) Secondary level male students
    b) Secondary level female students
7) To compare the effect of flipped classroom and lecture method on creative thinking of-
    a) Secondary level male students
    b) Secondary level female students

The hypotheses of the study were: -

Null Hypotheses

$H_0$1- There is no significant difference between the science teaching taught through flipped classroom and that of through lecture method on Science Achievement

$H_0$2- There is no significant difference between the science teaching taught through flipped classroom and that of through lecture method on Scientific Attitude

$H_0$3- There is no significant difference between the science teaching taught through flipped classroom and that of through lecture method on Creative thinking

$H_0$4- There is no significant difference between the level of science achievement of Government secondary level students taught through flipped classroom and that of through lecture method.

$H_0$5- There is no significant difference between the level of science achievement of Private secondary level students taught through flipped classroom and that of through lecture method.

$H_0$6- There is no significant difference between the level of scientific attitude of Government secondary level students taught through flipped classroom and that of through lecture method.

$H_0$7- There is no significant difference between the level of scientific attitude of Private secondary level students taught through flipped classroom and that of through lecture method.

$H_0$8- There is no significant difference between the level of Creative thinking of Government secondary level students taught through flipped classroom and that of through lecture method.

$H_0$9- There is no significant difference between the level of Creative thinking of Private secondary level students taught through flipped classroom and that of through lecture method.

$H_0$10- There is no significant difference between the level of science achievement of secondary level Male students taught through flipped classroom and that of through lecture method.

$H_0$11- There is no significant difference between the level of science achievement of secondary level Female students taught through flipped classroom and that of through lecture method.

$H_0$12- There is no significant difference between the level of scientific attitude of secondary level Male students taught through flipped classroom and that of through lecture method.

$H_0$13- There is no significant difference between the level of scientific attitude of secondary level Female students taught through flipped classroom and that of through lecture method.

$H_0$14- There is no significant difference between the level of Creative thinking of secondary level Male students taught through flipped classroom and that of through lecture method.

$H_0$15There is no significant difference between the level of Creative thinking of secondary level Female students taught through flipped classroom and that of through lecture method.

Operational Definitions of the Terms Used in the Study

Flipped Classroom- It is a type of blended learning in which learning is flipped. In this study flipped classroom is used as an independent variable. In flipped classroom before class learning material is provided to students in the form of video and text and in-class students are involved in a group activity. Knowledge and understanding level of learning is completed at home and higher order level of learning is completed in the classroom and students ask their doubts to the teacher. During class, students are busy interacting with their peer group and the teacher act as an observer and facilitator.

Lecture Method- In this study lecture method is used as the independent variable. It is an organized form of verbal presentation with question answers and often used charts by teachers to make their lessons easy and understandable.

Science Performance- science performance includes scientific attitude, science achievement, and problem-solving ability.

Scientific Attitude- Scientific Attitude referred to a mindset of an individual to act in any situation and way of thinking, accept or reject anything with some degree of favor or disfavor, scientifically and logically solve a problem, critically evaluate a particular entity, curiosity about nature, patiently observe and broadly think without any other biasness.

Science Achievement- Science achievement refers to obtaining a score on a science achievement test.

Creative Thinking- refers to new and innovative ideas to cope with any situation and problem differently and think uniquely.

Secondary Level- In this study secondary level means IX class.

Intelligence- it means the rate of success in academic achievement, problem-solving, adjustment and critical thinking ability.

Socio-Economic Status- level of economic difference of parents in the society.

Design of Study

Quasi-experimental design (Nonequivalent control group posttest only design) was used to conduct the study.

Population

A population is any group of individuals who has one or more characteristics in common that are of interest to the researcher. (Best & Kahn, 2006)

The population of the present research was the total students of Government and private schools at the secondary level of Darbhanga town of Bihar.

Sampling Method

The present study researcher selected both government and private schools through non-probability (conveniently). For the government school, researcher has chosen the B.K.D Zila high school Darbhanga and considering the private school researcher elect the Salfia school Darbhanga. The sections were randomly assigned to the control and treatment groups.

Sample and Sample Size of the Study

For this study, all those students who were present in the IXth sections of chosen schools are made the sample of the study. Sample size of the study was 160 which were taken from both schools, 80 students from government (B.K.D zila high school) and the other 80 students from private (Salfia School).

Tools Used in the Study

It is used for the data collection, constructed by researcher and expert. In this study following tools were used-

(1) Socioeconomic status scale by Sunil Kumar Upadhyay and Alka Saxena
(2) Group test of General mental Ability by S.S Jalota
(3) Verbal test of Creative thinking by Baqer Mehdi
(4) Scientific Attitude Scale: A rating scale constructed by the researcher to measure the Scientific Attitude of students of the IXth class.
(5) Science Achievement test: An objective type of question like a multiple-choice type is constructed and standardized by the researcher to measure the science achievement of IXth class students.

Conduction of Experimental Research

Since the study is experimental, data collection is time taking and it is very important to work in the research process. For that firstly, we selected two schools conveniently one belonged to a private school (Salfia School) and the other was a government school (Zila School). The researcher only selected that school that had at least two sections of IXth class. The researcher visited the schools and met the students and science teacher of IXth class. Two sections were randomly selected (fish bowl method) for the treatment and control group. Before the treatment, Covariate variables (Intelligence level and socio-economic status) tests were administered among both group experimental and control groups. Collect the phone numbers of all students and made a WhatsApp group of control and experiment group students. The topics were selected from IXth class syllabus of Biological Science which was common in both private and government schools. The Control group was taught Science (Biology) through the lecture method and the experimental group was taught Science (Biology) through the flipped classroom. The researcher provided the learning

materials in text form by hand and videos were provided by WhatsApp, related to selected topics. In flipped classroom students were given one day time to read the text material and watch the videos to prepare the questions which were discussed during class time. The next day, in the classroom students, had given chance to ask their doubts. Firstly, doubts were cleared by students and then after teacher (researcher) cleared them. Second, the next day group discussion was held during class time. All processes continued run until treatment was not completed and the other hand in the parallel control group was taught through the lecture method. After completion of treatment, the researcher conducted tests of dependent variables (Scientific Attitude, Science Achievement and creativity test) and compared the scores of dependent variables between the groups and also saw the effect of independent variables with respect to attribute variables

Analysis of Data

Scores were obtained by all the students of different tools had been carefully collected, coded and analyzed by appropriate statistical techniques. There are different statistical techniques are used in data analysis according to data type and method of the data collecting process. Mean, S.D, Leven's test for homogeneity of variance, skewness and kurtosis for normality, correlation and ANCOVA were used to analyze the data.

Delimitations of the Study

Present study has some limitations.

- It is limited to only Darbhanga town (Bihar) and at secondary level.
- It is difficult for a researcher to teach all subjects in their experimental study so it is only limited to science, especially biology teaching.
- One Government and one Private school were taken in this study.
- It only checked the science performance (scientific attitude, science achievement, and creative thinking).

Finding and Conclusion

Finding-1 (a)

Research question-1 Does the flipped classroom effects on science achievement?

Objective No.-1 To compare the effect of flipped classroom and lecture method in terms of science teaching at secondary level students on-

a) Science Achievement

Flipped classroom (M= 31.30) and lecture method (M= 31.66) When socio economic status was taken as covariate then, F ratio of data set were respectively. **[$F_{(y, x)}$ (1,157) =.061, p=0.805>.05].** When Intelligence was taken as covariate the F ratio data set were respectively **[$F_{(y, x)}$ (1,157) =.055, p=0.815>.05].** express a similar effect in terms of science achievement of students. When their socio-economic status and intelligence were taken as covariates.

Finding 1 (b)

Research Question- 2 Does the flipped classroom effect the scientific attitude?

Objective no. 1 To compare the effect of flipped classroom and lecture method in terms of science teaching at secondary level students on-

b) Scientific Attitude

Result led to the interpretation that those students who were taught through flipped classroom (M= 154.725), F ratio data set were respectively **[$F_{(y, x)}$ (1,157) =13.456, p=0.000<.05].** When intelligence was considered as covariate then the F ratio data set were respectively **[$F_{(y, x)}$ (1,157) =13.038, p=0.000<.05].** had more scientific attitude in comparison to those students who were taught through lecture method (M= 144.21) When their socio-economic status and intelligence were taken as covariate.

Finding 1 (c)

Research question- 3 Does the flipped classroom effect creative thinking skill?

Objective- 1 To compare the effect of flipped classroom and lecture method in terms of science teaching at secondary level students on-

a) Creative thinking

Results leads to the interpretation and reached the conclusion that both experimental (M= 97.41) and control group (M= 95.787), the F ratio data set were **[F $_{(y, x)}$ (1, 157) = .029, p =0.864>.05]** and when intelligence was taken as covariate the F ratio data set were **[F $_{(y, x)}$ (1,157) =.036, p=0.835>.05].** Found to be equally effective in terms of creative thinking of students. When their socio- economic status and intelligence was taken as covariate.

Finding- 2 (a)

Objective-2 To compare the effect of flipped classroom and lecture method in terms of science teaching on science achievement of-

a) Govt. Secondary level students.

Furthermore, to check the level of science achievement of government secondary level students taught through flipped classroom (M= 25.75) and that of through lecture method (M= 26.40). ANCOVA was computed to analyze the data and the F ratio of data set were **[F $_{(y, x)}$ (1, 77) = .053, p= 0.819>.05]** when socio- economic status was considered as covariate and when Intelligence was taken as covariate the F ratio data set were **[F $_{(y, x)}$ (1, 77) =.0394, p=0.532>.05].** After analysis researcher reached the conclusion that there was no significant difference between the students who were taught by flipped classroom and that lecture method, controlling the effect of socio-economic status and intelligence (covariates).

Finding- 2(b)

Objective-2 To compare the effect of flipped classroom and lecture method in terms of science teaching on science achievement of-

(b) private Secondary level students.

It also concluded that science achievement of private secondary level students who were taught through flipped classroom (M= 36.85) and that of through lecture method (M= 36.92), F ratio data set were respectively **[F $_{(y, x)}$ (1, 77) =.000, p=0.984>.05].** When intelligence was taken as a covariate the F ratio

data set were **[F $_{(y, x)}$ (1, 77) =.003, p=0.953>.05]**, had a similar effect having controlled the effect of socio-economic status and intelligence (covariates).

Finding- 3 (a)

Objective- 3 To compare the effect of flipped classroom and lecture method in terms of science teaching on scientific attitude of-

(a) Govt. Secondary level students.

Researcher come to the conclusion that students of flipped classroom (experimental group) (M= 149.7), lecture method (Control group) (M= 146.725) and when socio-economic status was taken as covariate then F ratio = **F (y, x) (1,77) = .622, p=0.433>.05.** intelligence as a covariate the F ratio data set were **F (y, x) (1,77) = .423, p=0.517>.05.** Had equal scientific attitude of government secondary level students. When their socio-economic status and intelligence were taken as covariates.

Finding- 3 (b)

Objective-3 To compare the effect of flipped classroom and lecture method in terms of science teaching on scientific attitude of-

(b) private secondary level of students.

F ratio of private secondary level student's data set were **[F $_{(y, x)}$ (1,77) =29.921, p=0.000<.05**] when socio- economic status was taken as covariate and when intelligence was considered as covariate then F ratio of data set were **[F $_{(y, x)}$ (1,77) =31.080, p=0.000<.05].** It concluded that private secondary level students who were taught through flipped classroom (M= 159.75) had more scientific attitude in comparison to those students who were taught through lecture method (M= 141.7). When their socio-economic status and intelligence were taken as covariates.

Finding- 4 (a)

Objective no- 4 To compare the effect of flipped classroom and lecture method in terms of science teaching on the creative thinking of-

(a) Govt. Secondary level students.

Creative thinking of government secondary level student's F ratio data set was when socio economic status was taken as covariate **[$F_{(y, x)}$ (1,77) = .608, p = 0.438>.05]** and when controlling the effect of Intelligence (Covariate) the F ratio data set was **[$F_{(y, x)}$ (1, 77) = 1.839, p=0.179>.05],** had no significant difference between the experimental group who were taught through flipped classroom (M= 87.32) and control group who were taught through lecture method (M= 96.62). When controlled the effect of socio-economic status and intelligence (covariates).

Finding- 4 (b)

Objective- 4 To compare the effect of flipped classroom and lecture method in terms of science teaching on creative thinking of-

(b) private Secondary level students.

Creative thinking of private secondary level students' F ratio of data set were respectively **[$F_{(y, x)}$ (1,77) = 1.44, p = 0.234>.05]** and controlling the effect of Intelligence (Covariate), the F ratio of data set **[$F_{(y, x)}$ (1, 77) =1.939, p=0.168>.05],** had no significant difference of experimental (M= 107.5) and control group (M= 94.95) when their socio-economic status and intelligence were taken as covariate.

Finding- 5 (a)

Objective- 5 To compare the effect of flipped classroom and lecture methods on science achievement of-

(a) Secondary level male students.

F ratio of science achievement of secondary level male students when controlling the effect of socio-economic status (covariate) was **[$F_{(y, x)}$ (1, 74) = 7.443, p= 0.0098<.05]** and having controlled the effect of intelligence (covariate) was **[$F_{(y, x)}$ (1, 74) =6.332, p=0.014<.05].** Those who were taught by flipped classroom (M= 24.31) were less effective in comparison to those who were taught through lecture method (M= 33.34) controlling the effect of socio-economic status and intelligence (Covariates).

Finding- 5 (b)

Objective-5 To compare the effect of flipped classroom and lecture method of science achievement of-

(b) Secondary level female students.

F ratio of secondary level female students were when controlling the effect of socio-economic status **[$F_{(y, x)}$ (1, 80) = 6.143, p= 0.015<.05]** and having controlled the effect of intelligence (covariates). **[$F_{(y, x)}$ (1, 80) = 3.692, p=0.058>.05].** Those who were taught through flipped classroom (M= 33.94) had more science achievement in comparison to those who were taught through lecture method (M= 27.96) when their socio- economic status was taken as a covariate. When controlling the effect of intelligence, there was no significant difference between the science achievement of secondary level female students, who were taught by flipped classroom and students who were taught by lecture method.

Finding- 6 (a)

Objective- 6 To compare the effect of flipped classrooms and lecture method on scientific attitude of-

(a) Secondary-level male students.

F ratio of data set of secondary level male students were when socio- economic status and intelligence were taken as covariate respectively **[$F_{(y, x)}$ (1,74) = 5.662, p = 0.020<.05], [$F_{(y, x)}$ (1, 74) =3.155, p=0.08>.05].** male of experimental group (M= 148.13) had more scientific attitude in comparison to control group (M= 139.2). When their socio-economic status was taken as covariate. When controlled the effect of intelligence (covariate) there was no significant difference between students' scientific attitude of secondary level male students, who were taught by flipped classroom and students who were taught by lecture method.

Finding- 6 (b)

Objective- 6 To compare the effect of flipped classroom and lecture method of the scientific attitude of-

(b) Secondary level female students.

Controlling for the effect of their socio- economic status and intelligence (covariates) F ratio of data set of secondary level female students were respectively **[$F_{(y, x)}$ (1,80) = .256, p = 0.614>.05]** and **[$F_{(y, x)}$ (1, 80) =.271, p=0.604>.05].** Scientific attitude of secondary level female students who were taught through flipped classroom (M= 157.22) had equal effect of those who were taught through lecture method (M= 155.22). When socio- economic status and intelligence were taken as covariates.

Finding- 7 (a)

Objective- 7 To compare the effect of flipped classroom and lecture method of creative thinking of-

(a) Secondary level male students.

The F ratio of data set of secondary level male students was **[$F_{(y, x)}$ (1, 74) = 3.138, p= 0.081>.05]** and when controlling the effect of intelligence, then F ratio of data set was respectively **[$F_{(y, x)}$ (1, 74) = 2.434, p=0.123>.05].** It revealed that, there was no significant difference between the creative thinking of secondary level male students who were taught by flipped classroom (M= 71.95) and that of through lecture method (M= 95.49) controlling the effect of socio-economic status and intelligence (covariates).

Finding- 7 (b)

Objective- 7 To compare the effect of flipped classroom and lecture method of creative thinking of-

(a) Secondary level female students.

Creative thinking of secondary level female students' F ratio of data set was having controlled the effect of socio- economic status **[$F_{(y, x)}$ (1, 80) = .582, p= 0.448>.05]** and when intelligence was taken as (covariate) the F ratio of data set was respectively **[$F_{(y, x)}$ (1, 80) =.017, p=0.898>.05].** Result explains that there was parallel effect of creative thinking of secondary level female students, who were taught by flipped classroom (M= 107.07) and students who were taught by lecture method (M= 96.44) having controlled the effect of socio-economic status and intelligence (Covariates).

Educational Implications of the Study

Conclusions have been drawn from the research findings from which some practical implications have been presented in this section.

- Since the science achievement of government and private secondary level students and secondary level male students cannot be better achieved by flipped classroom. Type of school did not significantly affect on science achievement. However, flipped classroom has other non-cognitive advantages which is only possible through it for example learning together, live together, meaning full engagement at home, divergent thinking, to consult with the extra learning material, learning with own pace, and cooperative learning. But in comparison between males and females who were taught through flipped classroom the female students had more science achievement compare to male students when their socio-economic status and intelligence were taken as covariates. In the other side lecture method, male students had more science achievement than females when their socioeconomic status and intelligence were taken as covariates. So, gender significantly affected flipped classroom in terms of science achievement. It was observed by researcher during the experiment during class time female students were more motivated toward the flipped classroom. They actively participated in group activity and followed the instructions very carefully compare to boys. This result will compel the teacher to more focus on boys' discipline and motivation. Female students had much more ability to adopt this new method compare to boys. Flipped classroom preferably may be used among the girl learners.
- Science achievement of secondary level female students was better achieved by flipped classroom when their socio-economic status was taken as covariate.

But when intelligence was taken as a covariate science achievement was equally achieved by flipped classroom and lecture method. Teacher should focus on heterogeneity of classroom in respect of gender, intelligence and socio-economic status of students. In group activity heterogeneity of students should take group should be mixed in nature. School administration should consider the heterogeneity of the students and the classroom when creating the sections. They also ensure the heterogeneity of teachers at the time of new recruitment which is sensitive regarding different types of students.

- Flipped classroom students had a more scientific attitude compared to those students who were taught the lecture method. Government secondary level students had an equal scientific attitude toward those who were taught through flipped classrooms and those who were taught through the lecture method. But the private secondary level students of experimental group had more scientific attitude compare to control group. Scientific attitude can be better achieved by flipped classroom. The type of school significantly affected on the scientific attitude of secondary level students it means school environment, management and discipline were effects on scientific attitude. So, the policymaker should focus on the school environment, discipline and management. Secondary level males of experimental group had a more scientific attitude in comparison to control group but in the case of secondary-level female students had equally significant who were taught through flipped classroom and that lecture method. Further in the case of flipped classroom male and female, the female had a more scientific attitude than males. Overall, it may be said that a scientific attitude can be better achieved by flipped classroom. This is a good inclination towards science to realize the objective of scientific attitude flipped classroom may be used secondary level students. Directive Principles of State Policy, in fundamental duties of part IVA (51A, h) said that to develop the scientific temper. Scientific temper means individuals have attitude of logical and rational thinking. Aims of Secondary Education Commission (1952-53) has to develop a scientific attitude of mind to think objectively and should not think confusedly. So that's good for implementing the flipped classroom. Teachers, policy makers and school administration should take action to adopt this new method of teaching. The National Council of Educational Research and Training (NCERT, 1961) focuses on science education and developing scientific attitude in

students. So, to fulfill the objectives of science teaching teachers should use the innovative (Flip Classroom) method in classroom. To implement the flipped classroom some guidelines should follow by teachers- In the flipped classroom learning materials are given to students before the class, so the teacher should make ensure the language of the learning materials is easy and in accordance with the medium of instruction. Any images included in the text or video should be related to the students' locality. Video sound should be clear and noiseless. Teachers should prepare the learning materials according to the age, level of psychology and understanding of the students. Special care should be taken that the learning material text and video are in whatever format the students take interested in. The video and text should not be too long which would deprive the student's interest. By what means should the learning material be provided? The teacher should ensure that the material is provided to all the students in a uniform and easy way. After providing the material to the students, the teacher should motivate them in a better way so that they study the given material and then attend class. After providing the learning materials, students should be given time according to the syllabus or according to the time given to complete the chapter so that they can study the material in a better way.

- Creative thinking is equally effective for students who were taught through flipped classroom and those who were taught through lecture method, government and private secondary level students and secondary level male and female students. But in other hand female students have more creative compare to male students in flipped classroom when socio-economic status and intelligence were taken as covariates. Female learner adopts flipped classroom in a better way than male learner. Preferably flipped classroom are used for female students. Creative thinking cannot be better achieved by flipped classroom in the context of the type of school and gender. So, the teacher ensured that the learning materials which were provided to students were attractive and interesting. Teacher should include some puzzles type questions in their learning material. Students should be instructed to take notes of questions that come to their minds during the study and ask the teacher in the classroom session to answer these questions. Teachers should prepare to answer all the possible questions related to learning materials that have been provided to students. For concept exploration, any group activity should be conducted by

teacher must ensure this will better improve the performance of science teaching (Science achievement, scientific attitude and creative thinking). Teacher should try to involve all the students; the small group should create and give chance to each student to put their views. Teacher should observe them, lead them and most importantly ensure the exploration of concepts in students and satisfy them. Secondary Education Commission (1952-53) aimed that education should provide such type of environment in which the child will be able to creative and constructive activities. School administration should also focus on the school environment, facilities in schools like a laboratory, library availability of different resource books, enrich the library and other resources related to the flipped classroom. They should conduct workshops on modern teaching methods and innovative resources of information so that in-service training of teachers can take place. Make the school environment more conducive. School administration should conduct time to time such type of meetings in which teacher can share their experiences with each other and find the solutions to the problem encountered in the teaching strategies used by them. The National Council of Teacher Education (NCTE, 1995) also recommended training the teacher with innovative methods of teaching. Government Policies DIKSHA and NISHTHA are currently run to train the teacher with innovative methods and flipped classroom according to the nature of the content. It also trained the teacher to manage classroom discipline, engage all students, and to take care of the heterogeneity of students in classroom, this will also help to teacher to use effectively flipped classroom. Policy makers should also focus on which type of policies are recently run-in teaching-learning process. Check the feasibility of this at the ground level, is the policies implemented in the right way, whether they effective or not effective? Policymakers should formulate a policy to adopt a modern teaching method, to conduct a program to update the information of the teacher and which is effective for them. But in spite of all these flipped classrooms can realize the social aim of education and only the basis of cognitive development or science performance we cannot say flipped classroom was not effective it's much more effective on non-cognitive development of students.

Suggestions for Further Study

Besides all these educational implications, the researcher has gained some experience for future research during her research. Research alone cannot cover all aspects of a problem. It is clear that different types of teaching methods have different characteristics and different prose and cones. There are various areas and dimensions of this study that could not be covered in a fixed time and single framework. Based on the experience gained from the current research, the researcher has been able to give some suggestions for further research which are as follows.

- Only government and private school students were included in the study, while other types of schools, such as Navodaya and Kendriya Vidyalaya, could also be included in the research.
- Since flipped classroom did not much effective for cognitive development so more research on their instructional design.
- The study was conducted at the secondary level. It can be conducted at every level of education (primary, higher secondary) and other classes of secondary level.
- In the present study only science performance (science achievement, scientific attitude and creative thinking) was taken while other variables related to the performance of science can be applied like critical thinking, problem-solving ability etc. can be taken and other than science subjects like social sciences, environment, mathematics and languages etc. study can be done.
- The study was conducted in the Darbhanga city of Bihar. However, it can also be done in other districts, city and village's schools.
- In this study, the flipped classroom was compared with the lecture method of teaching. The flipped classroom can also be compared with other teaching methods.
- The study was conducted at the school level, it can also be seen the effects of flipped classrooms on the college and other programs running in the college.
- The current study was conducted only on regular mode students and can also be done on distance mode students.

Chapter-1

Introduction of the Study

Chapter- 1

INTRODUCTION

Education is the basic source of human development. In the words of French revolutionary Dounton, "After bread we need Education." Education is more than simply learning how to read and write. Education aimed to grow personally, and socially. It supports us to become a better version of ourselves and expand our vista. It helps us to understand the rituals of different societies and cultures. Albert Einstein said that "Education is the training of the mind to think not the learning of facts". To achieve education and provide it to all the common people is a very complex process. As education is a fundamental human right that must be upheld in accordance with the country's constitution, for that to provide effective education for millions of youngsters it increased the intricacy of when a country like India. Education develops Social, Moral, Emotional & Spiritual values in human beings. Due to its importance, it becomes the fundamental right of all children (free and compulsory education) aged 6-14 (Article 21). According to the ***Dakar Framework for Action (UNESCO 2000),*** "One of the fundamental human rights is education". In order to effectively participate in the communities and economies of the twenty-first century, which are impacted by fast globalization, it is essential for continual development, peace, and stability both inside and among nations. Education is an instrument of social change and it needs to be remolded to understand the

rapid scientific advancement. Government makes many educational policies and programs to train the teacher through different methods of teaching according to subject content. Science doesn't ease our life, comfortable and a time saver but also protected our lives with the help of vaccination, medicines, and different operating instruments. The establishment of the Royal Society in 1664 marked a turning point in the history of science education. There were several different scientific academies opened in the 17th century. Science became more accessible to the person throughout the 18thcentury indu strial revolution. It might be argued that the breathing of the human species ma rked the beginning of science. Science education in India has been greatly accelerated after independence. Keeping in mind the importance of science All India Seminar on Teaching Science was conducted in 1956 at Tara Devi, and talks on almost every facet of science education in schools were held there. It proposed a distinct and standard method of science education for the entire nation, according to its need and available resources. Resolution on National Scientific Policy (1958) had more focus on science and scientific research. All levels of education are very crucial for the learner. Because all have their importance, benefits, and opportunities and it has a crucial position in the education system according to learner age and psychology. But the secondary level has its specialty and it is a link between elementary and higher secondary education. In its earlier report from the International Commission on Education (1993–1996), it was stated that secondary education is a "crucial point in people's lives; it is at this stage that young people should be able to decide their

future, in light of their tastes and aptitudes, and they can acquire the skills that will make for successful adult life. Thus, it must be modified to account for both the various maturation processes and the needs of the economy and society. The national policy of Education (2020) has noticed the importance of secondary education so it ensured that 100% Gross enrollment ratio from pre-school to secondary levels by 2030 and extended the grade level up to 12 of the right to education. The secondary level of education offers all the basic subjects like Science, Math, Social Sciences and Languages to students before going to higher studies. At this level, students find their passion and abilities which they can use in their future professional development. Students at the secondary level are very curious to know why did something happen because at this level students are in the adolescent stage and in all the stages of life this stage is very specific. How does something work? What is this? When will something happen? Curiosity about nature, what makes it? Foundation, invention and creativity all these questions are in their mind. But with the help of science teaching, we can nurture and satisfy something of that. So, students not only opting for science as a subject but also make their future in this subject as it gives satisfaction and also develops a personality. at the secondary level science is not only opting as a subject for higher studies and making the future in science but also the satisfaction of students and personality development.

1.1 Science Education

Science (Latin word Scientia meaning "knowledge") is concerned with the facts of the world we live in. Science is the methodical organization of information

in the form of testable explanations based on facts that have been observed or experienced. Science is the process of learning new things and gaining information through observation, experimentation, testing, and hypothesis-forming. Since the questions asked and the approach taken to finding the answer influence the knowledge received, process and knowledge are mutually reliant. Understanding, prediction and control have major components of science. **Paul, E. Blockwood** defines Science as "Men's relentless search for verifiable patterns, concepts, descriptions or explanation of phenomena in the universe"

"Science is collected and systematized learning in broad usage restricted to natural phenomena," the Columbia Encyclopedia (1963) stated.

According to **Fitz Patric,** science is "a cumulative and unending set of empirical observations leading to the construction of conceptions and hypotheses, both of which are subject to revision in light of further empirical observation. Science is both a collection of knowledge and a method for learning and acquiring knowledge.

Thurber and Collete "Science can only justify its inclusion in the curriculum when it results in significant changes in young people's habits, values, and ways of thinking."

The characteristics of science implied in the definitions stated are summarized as follows-

Science studies interrelations between facts and it are objective in nature. Science is a method of inquiry and discovery and it is self-corrective in nature.

Chapter- 1 Introduction

The basic aim of science is theory building, it is an organized body of knowledge based on assumptions. That science should be taught to achieve in life since science education is crucial because it develops the skills necessary for success in academic and personal life as well as improving life quality. In the 21st century, science becomes an immense part of our life. At this time, it is a need of our society to develop the field of science & technology. Our government policies & scheme related to education should focus on science education & teaching. "In a world founded on science and technology, education defines the level of wealth, welfare, and security of the people," the Education Commission (1964–1966) declared. Science helps us to understand motion, the evolution of life, chemical constituent, human physiology, plant physiology etc. Biology theory cannot contradict chemistry, physics cannot contradict biology and physics cannot contradict chemistry.

1.2 Need and Importance of Science Education for National Development

The advancement of the nation and society depends greatly on science. Science education is crucial for both domestic and global growth. Science and technology have ruled all over the country. The advancement of the world and country is built upon the accomplishment of science and technology. It builds the nation economically, socially, politically, educationally and in many other ways. In recent, those countries are more advanced in science and technology which are considered more powerful. That's why all the countries are in the race to the improvement of their science and technology and they more emphasis on science education. It involves all the sectors of the progress of any country. At

present moment most of the knowledge and information we received with the help of science and technology. The target of science education is to enhance the understanding of students, construct scientific knowledge, expand scientific literacy and make them answerable citizens. Students earn science education from school or colleges and despite these various workshops, online lectures, and camps are available to develop the cognitive skills and problem-solving ability of students. No stage of upgradation is free from technology and technology is only imaginable when advancement occurs in science. Science, technology and improvement are perfectly proportional to each other. Science and technology are mandatory for every aspect of the improvement and development of an individual or any country. In the current scenario, if any country is recognized as a developed country, it implies that it is also cutting edge in terms of industries, factories, science education, etc. Science and technology are influential tool for the rapid development of any country and it is necessary to associate with that country. The introduction of any new modern gadget eases our lives and it is only practicable to together implement science and technology. Without modern equipment and tools no sector even education information and communication, commerce, health or any other field cannot get the advantage of the advancement of this sector in today's life. No country became prosperous whether they are unable to fulfill the basic needs of their population and it is only feasible to empower and educate them. That's why in the present day every country advanced its education system and especially in

science education and they are in a race to advance their science education. So, they focused on the research of science pedagogy and want to improve it.

1.3 Importance of Science Education at Secondary Level

Science claims a primary place in the school curriculum is based upon the intellectual value of the scientific matter and its application to life. According to the National Curriculum Framework (NCF) 2005, teaching science involves teaching students the concepts, theories, and applications of science appropriate to their cognitive stage. Working on locally significant projects integrating science and technology as well as using systematic experimentation as a technique to find or test theoretical ideas are major components of the secondary stage curriculum. The curriculum should encourage students to acquire the techniques and procedures that result in the creation and verification of scientific knowledge, as well as satiate children's natural curiosity and foster their scientific inventiveness. Science provides the learner with the necessary information and abilities to enter the workforce by enabling them to understand the problems at the intersection of society, science and technology. Science instilled the qualities of honesty, integrity, and cooperation, along with the values of life and environmental preservation. Science also cultivates a "Scientific Temperament," which includes objectivity, critical thinking, freedom from fear, and the value of all people. Secondary education is the turning point for future citizens i.e., student’s life. of education system Additionally, according to the National Curriculum Framework (NCF) 2005, the school should have well-stocked libraries, labs, and educational technology

labs. Constructive learning must be a part of the curriculum. Students actively create their knowledge by relating new concepts to established ones using the materials and activities that are provided to them. The majority of science education in schools focuses exclusively on the cognitive domain, ignoring effective and psychomotor ones like attitude, reasons, skills and values. To address all aspects of science learning, Mc Cormack & Yager (1991) constructed a taxonomy of science education into five domains: knowledge domain, process domain, creative domain, attitudinal domain, and application domain.

Knowledge Domain (knowledge and understanding) refers to knowledge about scientific facts, concepts, principles, laws, theories and history.

Process Domain (Exploration and discovery)- Science process domains that involve observing, imagining, arranging, measuring, chart-making, classifying, predicting, and drawing conclusions, Proposing Hypotheses, testing hypotheses, interpreting data, controlling variables, making a conclusion, Generalizing and Handling apparatus, etc.

Creative Domain (Imagining & Creating) it refers to Visualization, combining objects' ideas in a novel way, Divergent thinking, applying ideas in a new situation, solving puzzles, Dreaming and Lateral thinking etc.

Attitudinal Domain (Feeling & Valuing)- the main motives of science are to develop a positive scientific attitude, confidence, respect for others' emotional states, and others' point of view, present one thought and emotions in a creative way and take a correct decision.

Application Domain (Using & applying) refers to applying knowledge, skills, and values in their daily life. Use a scientific way to solve their problems. Ability to evaluate science-related incidents, and decision-making related to personal health, nutrition, and lifestyle. Integration of science with other subjects.

Report of the review committee (1977) under the chairmanship of **Ishwarbhai patel** on the curriculum for the ten years of school recommended the objectives of secondary education about science are- Acquiring a general education that covers science, math, social studies, languages, and socially useful and productive work; exploring the world of work and becoming aware of life's reality to be ready for a confident exit from the school environment;

1.4 Objectives of Science Teaching in School

Science Education develops the ability, reasoning, curiosity, creativity, positive attitude, logical thinking, accepting the ups and downs of life, problem-solving approach and these abilities beautify or make the personality of students. According to a report of the Secondary Education Commission (1952- 1953) Science is taught in high school and higher secondary schools as a compulsory subject (Kothari Commission). To look at the importance of science education National Scientific Policy Resolution in 1958 foretell the bettering of science education and scientific research. Under the leadership of Shri. Lal Bahadur Shastri, the Indian Parliamentary and Scientific Committee was established in 1961 to examine the relationship between federal and state policies and

decisions and the curricula taught in schools. There are countless objectives of science teaching in schools-

Towards the Better Understanding of the Nature of Science- Fundamental principles of science, Scientific literature, Interrelationships of different branches of sciences, Health and the human body.

Towards Acquisition of Skills- Experimental skills, Handling apparatus, Constructional skills of making improvised aids, drawing skills, drawing diagrams, Problem-solving skills, Observational skills, measuring skills, classifying skills, Leadership skills, Critical thinking skills, Communicating skills etc.

Towards the Development of Scientific Attitude- Open-mindedness, Curiosity, Honesty, Critical mindset, Skepticism, Rationality, Objectivity, suspended judgment, Questioning attitude, Respect for evidence etc.

Towards Training in Scientific Method- Detecting a Problem: Identifying a Problem, the data's organization and interpretation, developing the theory, Validation and accuracy tests, scientifically reaching conclusions, etc.

Towards Development of Interest and Appreciation. It develops the value of Concern, Enthusiasm, Excitement, Leisure activity, Gratitude, Recognitions, Obligations, Tribute

With a View to Improving Students' Social Integration. Adjustment, Responsibility, Humanity, Respect of elders, Love for youngers, Brotherhood, Pacifist etc.

Towards Helping the Students Develop Suitable Career Interest. Helping the students to choose a career in their interested field. It develops the value of Cooperation, Guidance Counselling etc.

At the school level, the general objective of science teaching is to develop the scientific attitude, reasoning ability, logical thinking, problem-solving ability, etc. among students.

1.4.1 Scientific Attitude

Psychological factors such as thoughts, values, and perception, among others, have an impact on a person's attitude. Each of these complex factors influences how someone behaves. Values are ideas that serve as guiding principles or universal objectives that individuals work to achieve **(Maio & Olson 1998).** A person's attitude may be thought of as a psychological construct, an emotional and mental thing that exists inside them or defines them. It is sophisticated and learned via experience. It is a state of mind, how we react, what is our perception regarding the value, what is our receptive expression against a person, place, things, events, activities, ideas and traditions. Attitude is based on our feelings, and emotions It can be positive or negative. An attitude is "a psychological inclination that is represented by judging a particular entity with some degree of favor or dislike," according to **Eagly and Chaiken**. science promoting of our life either directly or indirectly. We learned the scientific method through science education, and we also acquired a scientific mindset as learners. The National Society of Study of Education defines “a scientific mindset as being

open-minded, desiring accurate knowledge, and anticipating that using this knowledge will lead to a problem's solution".

Jung's definition- is "the capacity of the mind to act or respond in a particular manner". It can be measured by using different scales and techniques. Similarly, the scientific attitude is the way of thinking reasonably, logically and clearly without any prejudices or preconceived notions. This is the age of science and logical thinking. Unscientific, illogical and irrational thinking can fall a nation and thwart its progress. So, it needs for our society to develop a scientific attitude in students.

"The Scientific Attitude of Mind entails eradicating all other desires in the interest of the desire to know. It entails suppression of hopes and fears, loves and hates, and the entire subjective emotional life, until we become subdued to the material and are able to see honestly, without preconceptions, without bias, without any wish other than to see it as it is, and without any belief that what it is must be determined by some relation, positive or negative, to what we should l." **Bertrand Russel**.

According to Grinnel," scientific attitude is not an approach to solve the world's problems, but a way of viewing the world"

Attitude is a state of mental development. It is a lens of an individual to see and act in any situation, every individual has a different vision. Children whose mental development is continuing at that phase we develop a scientific attitude because to understand any truth and they can't accept this without a base. In a child, undesirable attitude develops when we are unable to develop a scientific

attitude in them. The primary benefit of science teaching means to develop a scientific mindset. It is a habit or tendency to respond in a predictable manner to an unfamiliar or troublesome circumstance. The idea is cognitive in nature. Scientific attitude is another intricate behavioral element of research with a wide range of traits and applications. These behaviors are crucial to daily living and critical thinking for everyone, not just scientists.

1.4.1.a Characteristics of scientific Attitude

Scientific attitude evaluates the truth, is unbiased and depends on reliability. Scientific attitude is related to curiosity and new facts. It has objectivity and up to datedness. Persons who have a scientific attitude are open-minded and free from belief in superstition. It takes Suspended judgment, Critical observation and thought. Methodical way of solving a problem on hand belief in cause-and-effect respect for other opinions and accuracy, observation and truthfulness in reporting observations. Empathy for the plight of the human race, intellectual integrity, tenacity, self-assurance, scientific intuition, and ethics. It has determination acceptance of results humility and healthy skepticism.

1.4.1. b Importance of Scientific Attitude

Scientific attitude develops the ability to think and act systematically in students. It develops the ability to take decisions logically. It develops the curiosity to know their own environment. Which develops the value of Patience, biasness, truth and honesty. Scientific attitude is more or less in everyone. It enables man to understand the world openly, without any mystery, and to see the world from a different perspective. People with a scientific attitude do not

have stereotypes. Our society is bound by some of the old and wrong customs and traditions. Some educated people also get into superstitions like an incantation, ghost phantom, fear of danger if a cat crosses the path, spitting on a passing person from behind etc. and there are many other things that people still believe in today. Which is absolutely illogical. Scientific attitude liberates man from such kind of thinking. Therefore, a scientific attitude is necessary for man. Whether it is personal life or academic life, a scientific attitude is very important because in personal life for taking a decision and in social life, live with justice and honesty scientific attitude is very important.

1.4.1.c Development of Scientific Attitude

Instructors should constantly keep in mind that pupils cannot develop a scientific attitude without a questioning mind and an inquiring spirit. This is because teachers themselves must have a scientific attitude. Students should be encouraged to develop scientific attitudes, and for that, we should discuss the lives of many scientists, including their struggles, successes, hard work, and enthusiasm to inspire them. Answer every question which is asked by students, satisfy their curiosity and encourage them for asking questions. Teachers should give the chance of questioning and see the real face of their questions. We make students understand to students that we don't believe anything closed eyes, whether it is customary or uncustomary. firstly, we should verify the facts and then decide whether they may be considered or not.

1.4.2 Science Achievement

Achievement means to achieve something in any field whether education or career. In the educational field achievement primarily focuses on student success. Students' success is measured by the learning outcomes with their success and achievement. Everyone at all times tries for getting achievements, especially for jobs, in their career or any other selection in modern advanced societies, academic achievement is the most significant. It is very difficult to define achievement because it varies from individual to individual. Achievement is the attainment of performance or mastery of a certain skill or set of information. According to test results or instructor grades, it is the information acquired or skill gained in an area of study (Webster's English Dictionary, 1989). Academic achievement is a student's success in school, as measured by a grade or percentage in our educational system. For a prosperous educational future at the secondary level, strong academic accomplishment is required. Academic accomplishment refers to the level of academic achievement in school subjects that pupils obtained in their examination performance (Kohli 1975). Science achievement means students have sound knowledge of science, better scientific skills, good performance in science subjects and sophisticated marks in science according to their class level. In this study science achievement refers to the score of the science (Biology) achievement test which is taught by researchers during their experiment.

1.4.3 Creativity

Creativity is the creation of an idea or aim that is both advanced and useful. Creativity is an innovative plan that has value in solving problem or something that is modern or advantageous. Globally creativity exists. Each of us has some degree of creative ability. Despite being an inherent gift, creativity may be nurtured and made literate via education or training. Thinking that is creative cannot be limited in any way. It must have total freedom to accommodate the variety of replies. The term creativity cannot be used synonymously with giftedness/intelligence. Therefore, we should not make a mistake of considering every gifted/ intelligent child as a creative child. The ultimate manifestation of giftedness that may or may not be present in a specific gifted youngster is creativity in all of its structures and forms.

1.4.3.a Definitions-

Some notable scholars have provided the following definitions of creativity or the "creative process":

The creation of a "completely or partially" unique persona is implied by Stranger & Karwoski - creative (Crow &Crow,1973, P.314)

According to Drevdahl, creativity is the ability to create compositions, products, or ideas that are basically original and previously unheard of by the creator (1956, P.22)

Guilford, Christensen, and Wilson. The term "creative process" refers to any process that results in the creation of anything novel, whether it be an idea, an

item, or a combination of both. The new invention must aid in the resolution of some issues. (Dutt, N. K. 1974, p. 208)

According to Skinner's theory of creativity, an individual's predictions and/or conclusions must be novel, inventive, and uncommon. The person who thinks creatively investigates new regions and generates fresh observations, forecasts, and deductions. (M68, P529)

When we examine the aforementioned definitions, we see that the key component of all of them is the invention or finding of something new. Thus, it is simple to draw the conclusion that creativity refers to a person's aptitude or skill to come up with, find, or develop a new concept or product, including the rearranging or reshaping of what is already familiar to him.

1.4.3. b Characteristics of Creativity

1) There is Freedom to respond
2) There is an opportunity for ego involvement.
3) It encourages originality and flexibility.
4) Creative person doesn’t have hesitation or fear.
5) Creates a conducive environment and offers suitable possibilities for creative expression.
6) Encourage children's good practices.

The capacity to come up with novel, appealing and practical thoughts or ideas is referred to as creativity. Your ability to think creatively will help you generate unique and uncommon ideas. One-of-a-kind manifestations of creative thought

occur. A fantastic logo is made by a graphic designer. In his line of work, a photographer captures an uncommon frame. With his creative product, a product designer finds a solution to a problem. Not only artists, painters, or writers can think creatively. It provides all experts with a benefit. In practically every sector, it encourages innovation and advancement. Anyone can have an epiphanic moment when an idea clicks.

1.4.3.c How to Improve Your Creative Thinking

- Recognize your strengths and work to use them more frequently in your life.
- Channel your inner kid and discover the distinctive characteristics of youth, clarity of mind, and spontaneity of speech.
- Don't confine yourself to a routine. Think differently and express yourself in a new way. Avoid using stereotypes.
- Take pleasure in the outdoors and let your imagination run wild as you explore and experiment.
- Take an active interest in your environment.
- Don't be afraid to take chances to develop your skills.
- Eliminate the negative mindset that is stifling your creativity.
- Engage in brainstorming to generate fresh concepts.
- Recognize that there may be several ways to solve an issue, and investigate all options.

1.4.3. d Role and Importance of Creativity in Classroom

A good learning environment in the classroom includes certain creative components that make the session more engaging and participatory. Students are inspired to learn novel and inventive things when the curriculum contains the correct degree of originality. It creates good communication skills, emotions and good social skills in students. And they also learn how to apply it in a real-life situation. Indeed, creative expressions play a key role in students' emotional development.

1.4.3.e The Role of Creativity in the Present Classroom and its Benefits.

- **Learn with Fun-** Creativity allows for fun learning in the classroom. Teaching performance helps students to learn without stress.
- **Freedom of Expression-** In contrast to the traditional teaching approach, students have the chance to express themselves in the creative classroom. Whenever there is an opportunity for discussion or debate in the classroom, they get the chance to show themselves. Which makes them feel good and happy.
- **Emotional Development-** In a creative environment, students have the opportunity to speak and keep talking. As a result, their emotional development is enhanced and their confidence is also intensified.
- **Enhances Thinking Capabilities-** The opportunity to speak in the classroom and express one's feelings enhances their ability of thinking and understanding.

- **Reduce Stress and Anxiety-** Creative classroom promotes a positive attitude in students which helps to develop their creativity. Students are able to keep their words and express their emotions which makes them feel happy and thus they stay away from stress and anxiety.
- **Boosts Problem Solving Skills-** Creativity gives students the opportunity to think differently and encourages them to consider every possible aspect which develops their problem-solving ability.
- **Better Communicator-** Students have freedom of expression. A creative environment gives them the opportunity to think uniquely. Whatever he/she discovers, solve the problem differently and have to present new ideas in Infront of others. And this way they become a good communicator.

1.4.3.f Science and Creativity

The teaching of science in educational institutions is viewed as a subject that can assist students develop their capacity for creative thought. Most science students believe that scientific research or inquiry entails meticulous observation and data analysis to evaluate ideas. As creative as literature, music and the arts are, science is. Scientists must thus utilize their creativity to develop plausible theories. These explanations are well-informed; they are not just educated guesses, yet it is impossible to avoid the conclusion that they are essentially works of fiction. Science subject promotes creativity in students. The very nature of science involves thinking. It involves accepting the concept of innovation and usefulness. It is based on the truth and correct observation of

whether something is accepted or rejected. Science promotes problem-solving ability in students which promotes creativity. Innovative methods of teaching science such as group discussion, project learning, discussion, flipped learning, etc., given the opportunity to students to think and express themselves, which helps them to develop creative thinking.

1.5 Biological Science

As a field of science, biology is the head branch of science. It starts from when life has existed on the earth. Biology helps us to understand the living world, many species including animals (zoology) and plants (botany), functions (physiology) of living things, health and disease and its causes and precautions, medicines, agriculture, biotechnology, food production, ecological system etc. The study of life and living things, including their physical makeup, chemical composition, molecular interactions, physiological processes, development, and evolution, is known as biology. Because it helps people understand how the human body works and how to live a healthy, fit lifestyle, biology is crucial to daily living. In Biological science, we studied Food production, Food chain, Agriculture, Lac culture, Sericulture, Biotechnology, Biochemistry, medicine, medicines etc. Biological science is further divided into two main branches- Zoology and Botany. Higher education gives numerous opportunities and scopes to students to make their future in the field of biological science. Biological science has no separate syllabus at the secondary level. But the syllabus of science has its own objectives and importance. At this level, students are going through the adolescent stage and they have some physical changes.

That's why in the syllabus and curriculum the age of the learner has been given special focus. Like those chapters and lessons are included which are easily understandable, some innovative stories of scientists are included which motivate them and prevent all these things which adversely affect them. Physical safety, health, causes and prevention of disease, good habits for health, and the importance of cleanliness. Then students lead a healthy, neat, and tidy life. At this level students have been taught the body is made up of cells, tissues, and different organs, and organ systems and the objectives of all these lessons are to understand the functions of organs and different organ systems like digestive, respiratory, circulatory, excretory systems. Students excogitate or themselves and about nature and they know why all these organs are important for us and they can abstinent from toxic substances. At this level, the curriculum included- Food resources, crop protection, nutrient management, fertilizers, water augmentation, rain water harvesting, plant breeding, crop rotation, plants disease, pesticides, food storage, and natural resources theses chapters and sub-chapters develop the skills of farming, develop the values of sustainable development, humanity, and know the values of nature, foods, and environment. In this way, future citizens lead civilized and disciplined life. But all these values are only developed through the best method of teaching and teacher competency. There are various innovative methods of teaching biological science.

1.6 Methods of Science Teaching and Learning

Invention and discoveries are essential for the progress of society and for making life so easy. So, there is a need to focus on science education. Science education is the kind of instruction that enhances a person's capacity for logic and reason. The scientific way of thinking and ideas today have a special position in the world. The age of science and technology is now. Science-related education and research should be given more emphasis in order to boost the national economy. Consequently, math and science should be taught in schools as core subjects. From rise to sleep, every time and everywhere we are surrounded by products of science and technology. Every aspect of human life whether natural or artificial is filled with science, from their own internal biology to the alarm clock kept on the table. Children grow with science and technology in a scientifically advanced world. So that there is a requirement to literate them scientifically to succeed and survive better way in their life. UNESCO planning mission (1963) most important mission of all its mission is "Achieving high standards of education for all people, promoting lifelong learning, and mobilizing scientific knowledge and policy for sustainable development". These studies provide a general assessment of the state of science and math instruction in India and gave suggestions for improvement; hence, the focus of these reports was on science and math teaching strategies. Due to the relevance and importance of science, it becomes the basic subject of school education. The National Scientific Teaching Association (NSTA) exhorts the community of science educators to promote 21st-century skills that are

consistent with best practices in all facets of a science education system, including curriculum, pedagogy, science teacher preparation, and teacher professional development. National Research Center (NRC 1996). Science education gives students access to a plethora of knowledge and information that will help them get a general grasp of how and why things function the way they do. National Science Education Standards (1996) are intended to lead our country toward a culture that values scientific literacy. It assesses the caliber of science instruction, scientific programs that give children the chance to learn science, science support systems for teachers, and the caliber of assessment techniques and policies. This means that the aim of science instruction at the secondary level is to create students who can: Participate intelligently in public conversation and discussion about matters of scientific and technological significance; Discover the excitement and richness of learning about and comprehending nature; When making decisions for yourself, use relevant scientific ideas and processes; In an advanced world, no one underestimates the scope of science. Human existence is rudimentary based on science like-personal lives, healthy life, civic lives and economic lives. Science persuaded educators to include it as a subject in the curriculum beyond conventional justifications. The aims of science teaching and learning should be the acquisition of knowledge of scientific words, principles, and ideas, a thorough comprehension of them, the capacity to apply them in a variety of real-world circumstances, and the development of skills. In this scientific era, there is a need to inculcate the values among students with science education. The

national education policy for 2020 has placed a strong emphasis on cultivating in students a scientific mindset, an aesthetic sensibility, an ethical sense, and digital literacy. It means this policy suggests science education and teaching methods. For holistic development of students' subjects are just as imperative as the methods of teaching. The immense scope of science is taught by various methods according to age level, grade level, and nature of the content. Like the Lecture method, Heuristic method, Discussion method, Experimental method, Project method, Lecture cum demonstration method, Laboratory method, Cooperative learning method and so on.

In ancient times, there was no concept of books and printed learning material, in that age oral method of learning material has in trend. Children were instructed in a strict, regimented, and stereotypical manner. The idea of education at the time was limited to the transfer of factual information. The lecture technique, which the teacher frequently employed and was less efficient for fostering meaningful learning, The instructor did not employ any appropriate teaching aids to support his spoken instruction. But in the modern age, only the transmission of knowledge is not enough. The demand of time is to flourish the ability to think critically, scientifically, rationally, and divergently and develop problem-solving skill, etc. In his book Ignited mind Dr. Kalam criticizes the mindset of Indians to settle down with modest success without employing all of their resources, ability, skills, and potential, and he draws attention to the country's lack of global competitiveness. Additionally, Dr. Kalam encourages the blending of science and spirituality. "We shouldn't

mislead science because it is a wonderful gift to humanity." A. P. J. Abdul Kalam. According to this advanced world, the teacher needs to use the proper method of science teaching and learning material for effective learning. A contemporary educator views education as an interaction between the kid and his surroundings. Children learn by doing and how to learn both individually and in groups. Every second, the explosion of knowledge is changing how people live and have a significant influence on the educational system. To cope with this is only possible by using proper learning material which can be considered the development of educational technology.

Without using the different modern methods, the objectives of science teaching can't be achieved. At the very beginning, it may be noted that the teaching-learning process is a very complex mix of teachers, students, instructional and illustrative materials, and the pervasive atmosphere within a school setting. But today, thanks to educational technology has made the teaching-learning process very easy, and interesting for both students and teachers. In a highly restricted sense method of science, teaching means what to teach and how to teach it. It mostly depends on which types of learning material and methods have been used.

1.6.1 Lecture Method

The lecture method is a teacher-centered and traditional method. It is an oral presentation, the teacher talks and explains facts, and principles and wishes the students to understand, listen and take notes A lecture, in the words of Bligh (1972), is a teacher's more-or-less unbroken speech. A lecture is a "dialectical

educational style, including one-way communication from the active presenter to the more or less passive listener," according to Percival and Ellington (1988). In the 5th century BC, it was famous in Greek. It was gladly adopted by Christian and Muslim Universities in the medieval period. The word lecture is derived from the Latin verb lecture, which means to read aloud and indicates that it is an explanatory and instructive manner. This approach makes the instructor the exclusive source of classroom instructions, placing the teacher in charge and information-focused. The lecture is the unique alternative in situations where the number of students is huge or where there is a lack of teaching resources and the syllabus is completed in a very short period of time. The lecturer creates interest, promotes activity, develops critical thinking, and stimulates or motivates the students with a verbal message. In the lecture approach, the teacher supports the oral technique using maps, charts, or other visual aids, but only with a minimal amount of class participation. The lecture approach teaches students in two ways: first, through the lecturer's material presentation, and second, through their own information processing and reorganization. Therefore, the amount of information that is delivered, received, and processed by the learner determines how much is learned and understood using the lecture technique. A poorly designed, uninteresting, or useless lecture will prevent students from learning since it will be confusing. A lecturer delivers information through a variety of methods in the lecture method, including, verbal—using justifications, definitions, illustrations, descriptions, or remarks. Through the lecturer's voice attributes, such as clarity, audibility, fluency, and speed, more

verbal is conveyed. Nonverbal: through body language, facial emotions, and gestures. Visual—by utilizing visual assistance. Additionally, students pick up knowledge by observation, conversation, taking notes, and listening. The lecture is an efficient & helpful teaching style at this stage, according to numerous studies on teaching methods in higher education. However, it is less significant for students since activity-based learning has a considerably greater impact on a learner's overall growth. In fact, it is advised that the lecture method is inadequate for teaching science in primary and high school classes. It has less effect on higher cognitive levels, practical skills, laboratory work, changing of attitude, and achievement as compared to other methods. Recently it is not suitable for school education especially science teaching. In this competitive world, there are various methods for better understanding. Science teaching is mostly depending on activity, project, assignment, problem-solving, cooperative, laboratory, and hands-on experience methods.

1.6.2 Flipped Classroom

There are many advantages of incorporating technology into the classroom is that it makes it a lot easier for educators to employ different methodologies that allow students to learn more effectively, acquire different abilities beyond the subject content, and become engaged in the learning process. For the last few years flipped classrooms is on trend which is having a great impact on schools, colleges and universities for all subjects and disciplines. Although the paper did not explicitly advocate for the use of "flipping" classrooms, researcher Alison King first proposed the concept in 1993 in her article " from sage on stage to

mentor in the background." It made advantage of class time to impart knowledge and purpose to students. King's writings are frequently cited as the basis for the flipped classroom concept in support of this claim. The term "flipped learning" first into common usage in the early to mid-2000s, thanks to chemistry instructors Jon Bergman and Aaron Sams (Bergman & Sams 2012). the New York Times (Fitzpatrick, 2012), The Chronicle of Higher Education (Berrett, 2012), and Science (Mazur, 2009) for their exceptional works; Essentially, "Flipping the classroom" refers to the practice of exposing students to new material outside of the classroom, typically through reading relevant texts or watching relevant videos, and then putting great emphasis on assimilation during class time, perhaps through problem-solving, discussion, debates, etc. Barbara Walvoord and Virginia Jahnson Anderson promoted the use of this practice in their book Effective Grading (1998). They recommend a method in which students gain knowledge through hands-on training prior to class. A "pedagogical approach where direct instruction shifts from the group learning space to the individual learning space, and the resulting group space is transformed into a dynamic, interactive learning environment where the educator guides students as they apply concepts and engage creatively in the subject matter" is known as the "flipped classroom" (the Flipped Learning Network 2014). It is a reversal of the traditional method. Before the class, the teacher provides learning material to students at home and in the classroom, student debates, discuss and work on the application of the concept. The teacher makes short instructional material like audio clips, videos, visuals, and text to

learn from outside of class. In a flipped classroom the teacher works as a guide or Facilitator and has more time to clarify concepts while watching students as they work to detect any errors in thinking. It gives opportunity students to learn at their own pace and repeat the lesson according to his/her need. Jonathan Bergmann and Aaron Sams discuss in their books why teachers should use flipped classroom;

Flipping uses words that today's pupils understand.

Flipping the classroom promotes student engagement.

Flipping is beneficial for difficult kids.

Students of various abilities can succeed when they are flipped.

Students can stop and start their teacher by flipping.

Flipping increases interaction between students and teachers.

Teachers who flip classrooms get to know their students better.

Flipping schools alters how classes are run.

Flipping alters how we communicate with parents.

Flipping parents' attention.

Flipping opens up your classroom.

For absent teachers, flipping is a fantastic strategy.

Flipping can result in a program called "flipped mastery."

All these necessities are four major hurdles to applying this, there is a need to overcome these hurdles; Thinking differently; technological barriers; time management; teaching oneself to students and parents, and finding the time. Many types of research found that the flipped classroom positively affects

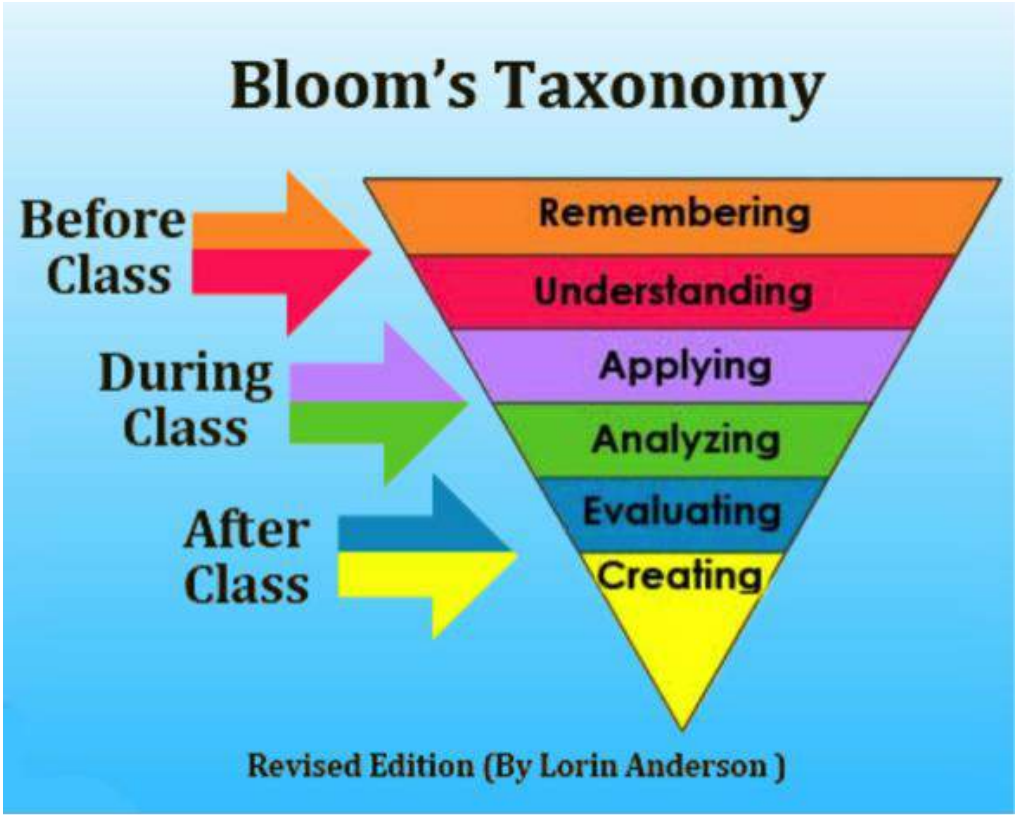
achievement, the performance of student's satisfaction, understanding of content, development skills, etc. flipped classroom is not only affected science subjects but also improves the learning ability of language students. This method helps to clear all the doubts about the respective content which is provided by the teacher. It encourages the students to group learning because this way students get more views and different ideas on the same topic. The flipped classroom encourages students to take more ownership of their education and gives them the chance to benefit from peer learning. The flip classroom is the inverse of the traditional method where learning material is delivered out of the class and homework moves into the classroom where the teacher serves as a guide. It changes the classroom scenario where students are more active whether the teacher made their activeness continuously and clear doubts and messiness of group activity. In recent times developing a scientific temper, attitude, problem-solving ability, creative thinking, critical observation, and scientific skills are very required to compete the life. All these abilities are very easily developed by science teaching with the help of flipped classroom.

According to The Flipped Learning Network (2014), the flipped classroom is "a pedagogical approach in which direct instruction moves from the group learning space to the individual learning space, and the resulting group space is transformed into a dynamic, interactive learning environment where the educators guide students as they apply concepts and engage creatively in the subject matter." In the conventional approach, students complete lower-level learning tasks like remembering and understanding in the classroom regardless

of whether they leave the higher-level learning, which is performed at home. The learning process is turned around in flipped classrooms. Before class, students can finish lower-level cognitive assignments, and when they arrive in class, they are already working on higher-level assignments.

Figure 1.1

Blooms Taxonomy revised Edition



Revised Edition (By Lorin Anderson)

1.6.2.a: Definitions of Flipped Classroom

The flipped classroom, according to **Bishop and Verleger (2013),** "It is a student-centered teaching technique that consists of two parts: one-on-one instruction that is totally computer-based and interactive learning activities that take place during the session."

According to **Mull (2012),** it is a system that enables students to prepare ready for the lecture by watching videos, listening to podcasts, and reading articles. "This strategy attempts to boost the effectiveness of courses by delivering knowledge to students through videos and podcasts as well as through discussions, group projects, and applications while the student is attending the course," states **Milman (2012).**

According to **Toto and Nguyen (2009),** the flipped classroom method improves active learning activities and allows students the chance to apply their knowledge in a classroom setting under the supervision of the teacher.

According to **Hamdan and others (2013),** the flipped classroom is a method that instructors utilize to balance out the expectations of their pupils rather than being a specified paradigm.

1.6.2.b Flipped Classroom Approach-

“What is done in school is done at home, and in class, homework that was performed at home (Sams & Bergmann, 2014)

A method is known as the "flipped classroom" involves giving students more responsibility for their own education (Bergmann, Overmyer & Wilce 2011). The teacher must adhere to the flipped classroom model's four prerequisites.

1) "F" (Flexible Environment): It denotes the learning environment's adaptability in terms of time, speed, and content.

2) "L" (Learning Culture): The instructor is the epicenter of knowledge in the conventional technique. However, in a flipped classroom, the emphasis shifts from teacher-centered to student-centered instruction.

3)“I” (Intentional Content): Teachers that employ flipped classrooms consider how to help students enhance their cognitive knowledge as well as how to use education to promote fluency.

4)“P” (Professional Educators): Teachers in flipped classrooms are held to higher standards of accountability. Flipped classroom instructors must continually monitor students during the lesson, assess their performance, and provide feedback (Flipped learning Network- FLN, 2014).

The focus of a flipped classroom is on interactive activities that take place in person between the teacher and students during class time rather than learning through internet recordings. The instructor in the video lesson is not replaced. It is not the case that they spend the entire class session in front of a computer. Students are not studying by themselves.

Flipped learning turns the classroom from passive to active. It engages to students in higher order thinking skills like evaluation, creation, and analysis of learning. This approach provides the possibilities for active learning and gives the opportunity to take responsibility for self-learning. The main motive of class time in flipped classrooms is to explore, find meaning, and application of knowledge.

1.6.2.c The Role of Teacher for Flipped Classroom

Bergmann and Sams,2012 says- in flipped classroom teacher play an important role like-

- Establishing question-based learning conditions (Bergmann and Sams, 2012)

- Rather than imparting knowledge directly, act as a facilitator to make learning simple (Johnson & Renner, 2012)
- Interacting one-on-one with pupils (Cohen & Brugan, 2013)
- Clarifying misinterpretations (Bergmann and Sams 2012)
- Customizing instruction for each student (Schmidt & Ralph, 2014)
- Using technology that is appropriate for a learning environment (Fulton, 2012)
- Establishing interactive conversation environments (Millard 2012)
- Increasing student involvement (Millard 2012)
- Sharing lectures as an extracurricular activity (Bishop & Verleger, 2013)
- Giving feedback while utilizing educational techniques (Nolan & Washington, 2013)

1.6.2.d: The Role of Student

- In a flipped classroom, students go from being passive consumers of knowledge to being active educators.
- Assuming responsibility for their own education.
- Watching lecture videos in advance of the course and using study resources to be ready for the course (Milman 2012)
- Acquiring knowledge at his own pace (2012)
- Interacting with his instructor and classmates as needed, offering and getting criticism (Tucker 2012)
- Participating in class discussions (Overmyer, 2012)
- Active participation in teamwork (Formica, Easley, and Sprater, 2010)

1.6.2.e: Flipped Classroom Method

The flipped classroom technique emphasizes the need for substantial interactive classroom activities rather than just teaching courses in conjunction with video recordings (Bergmann &Sams, 2012). In other words, the substitution of homework for in-class instruction is characterized as allowing students to concentrate on the issues they face during individual learning (Abeysekera & Dawson, 2015; Chen, Wang & Chen,2014).

The flipped classroom technique gives students flexibility in time and location, allowing them to study at their own speeds (Bergman & Sams 2012). As a result of students arriving to class prepared, participation in class activities is made simpler. Their interactions with the instructor and their peers improve because they feel at ease and are aware that they may obtain rapid assistance with even the most challenging tasks. They have the opportunity to get to know themselves better and take ownership of their education in this way.

Flipped classrooms allow students to learn at their own pace, motivate them to actively engage in lectures, free up class time for more useful, creative, and active learning activities, give teachers more opportunities to interact with and assess students' learning, and allow students to take responsibility for their education (Gilboy, Heinerichs & Pazzaglia, 2015; Betihavas et al., 2015).

To Conduct the flipped classroom there are many steps we have to follow to complete the lesson in the flipped classroom

1) Pre-class exposure to the topic

2)Incentives to learn

3)Student understanding assessment

4) In-class activities

5)The role of technology

1) Pre–Class Exposure to Topic-

There are many options to expose the learning materials before the class. Technology plays a major role to send recorded lessons and videos to their students, so they get the same idea, information, knowledge, and experience to attend the classroom. These materials can be varied as self-made videos, videos created by other teachers, PowerPoint, links, Moocs, Khan Academy, e-books, book chapters, magazine articles, printed papers, or any other kind of physical and digital format.

2)Incentives to Learn-

Teachers give instructions and motivate students to study learning material that is given before the class.

3)Student Understanding Assessment-

When students watch the videos and study the other learning materials at that time teachers are not physically present. It is necessary to develop methods to measure whether they are understanding the materials and what kind of questions are coming up in their mind. For this many educators conduct surveys and quizzes both before and during the flipped classroom.

4)In-class Activities-

Flipped classroom need some kind of activity to be performed during the class, in order to help students, get better familiarized with the materials and lessons

they studied before. The nature of these activities will vary according to each class, topic, and goal, but they will usually involve debates, discussions, group work, and other highly engaging and collaborative activities.

5)The Role of Technology

Technological tools such as e-mail, WhatsApp group and google classroom are helping to communicate between students and teachers. Memory cards and pen drives are also used to share videos, ppt, notes, audio etc.

Flipped classroom are a method that spins education and it helps to deliver traditional content and help their student to develop skills to use technology and prepared them for the digital world of learning. When we switch our paradigm from teaching to learning, we see education through new lenses, "seeing" our work from a fresh perspective and gaining a variety of experiences as we and our students work together to learn. Learning is not something you watch. Students cannot learn much by just remembering and repackaging tasks, sitting and answering questions in class. Instead, they must talk about what they are learning, write about it, connect it to what they already know, and use it in real-world situations. They must apply what they have learned to who they are (Chikering and Gamson, 1987). The basic idea behind the flipped classroom is that activities that are typically completed in class are now completed at home and in class. What is currently done at home is done in class in a flipped classroom. The flipped classroom, however, encompasses more than this.

1.6. 2. f Structure of Flipped Classroom

We begin class with a brief discussion of the lecture video and reading material that was previously sent. In homework assignments, students write questions to ask the teacher that comes to their mind, when they are taught through the given learning material. These inquiries help teachers assess the value of their lesson plans. If all of the students have the same question, the subject was not taught clearly. Teacher notes: This particular learning material has to be redone or corrected. Students' concerns and uncertainties have been addressed, and the day's homework have been given.

1.6.2.g: Need for Flipped Classroom

a) Flipping Speaks Today's Students' Language- Present-day students grew up with the digital world, internet access, YouTube, Facebook, My Space, WhatsApp, Instagram and other digital resources. They can solve their math problem while texting their friends, listening to music, post all at the same time. Students are habituated to digital devices so they take interest in learning with their own pace.

b**) Flipping Helps Busy Students-** Students appreciate the flexibility of this method. Everywhere and any time they learn, they pause and repeat the video. Students are free to learn.

c)Flipping Helps Struggling Students- Traditional methods are teacher-centered and the center of all the knowledge are teacher whenever they interact with their students bright and best students get more attention from the teacher. In that case average, below average, and dull students are passive and they may

be unable to understand what they are taught. After introducing the flipped classroom, they get chance to repeat and repeat their video and learning material and get benefitted. It is aimed at those who require the greatest assistance.

d)Flipping Helps Students of All Abilities to Excel- In the flipped classroom all the instructions are recorded, and students with special needs learn the material according to their needs. They do not need to copy and write down notes, whenever they want to remind the lesson, they can easily access the lesson.

e) Flipping Enables Students to Pause and Rewind their teacher, which Promotes Student Success Regardless of Ability- Teachers have to complete the syllabus in a particular time period. In the flipped classroom students have the control of a remote to pause and rewind their teacher

f) Increased Flipping Interplay between Students and Teacher- Flipping allows teachers to assess and evaluate the learning which is done by given learning material. It does not advocate the replacement of teachers with online and technical instruction. Teachers have a significant impact on their pupils' lives. Each student in a flipped classroom, where the teacher acts as a friend, mentor, and subject matter expert, has a different experience when they interact with teachers face-to-face.

g) Flipping Increases Student – student Interaction- The teacher's job in a flipped classroom has shifted from that of a content presenter to that of a learning coach who interacts with the students, responds to their questions, works in small groups, and mentors each student individually. When students

are working on an assignment they discuss it in a group, in this way they know the ability of their group members. Students develop their own collaborative groups, they help each other.

1.7 Significance of the Study

In School, curriculum Science plays a very crucial role. Success in science depends on how science is taught and learned. The pedagogy of science teaching is always highlighted in educational research. Our government trained many teachers in the pedagogy of different subjects, especially science. The degrees of learning of pupils are explained by the science pedagogy, or teaching and learning process. This research study signifies the importance of student-centered learning, learning at its own pace. Conventional methods of science teaching emphasize content knowledge, rote and memorization of content and reached the level of understanding. In current days the various methods in trends which helps to achieve a higher level of learning. But all of this Flipped classroom has a unique place in methods of teaching. This research study signifies the importance of learning at its own pace. Students are responsible for his/her own learning. Many other conventional methods are more focused on content knowledge, rote and memorization process of learning. But this teaching method actively involves the students. How do students learn by using different learning materials at home? What best way do they use audio, videos and text content etc. how do students indulge themselves in making concept? This method of the flipped classroom helps to achieve a higher level of learning in a short time and with limited resources.

1.8 Variables of the Study

1.8 .1 Independent Variables- Methods of teaching-

a) Flipped classroom and b) Lecture Method

1.8.2 Dependent Variables- Science performance-

a) Scientific Attitude, b) Science Achievement and c) Creative thinking.

1.8.3 Covariates- Socio-Economic Status and Intelligence

1.8.4 Attribute Variables- a) Gender (Male and Female) b) Type of School (Government and Private)

1.9 Knowledge Gap

Various related studies were reviewed. It was observed that there exist a wide variety of teaching method in the flipped classroom and respective studies were conducted. Flipped classroom was examined with different courses, computer applications, calculus course, STEM (Science, technology, engineering, mathematics) course, effect on students learning, English language learners, traditional classroom, instructional technology, and material development, at different school levels (primary, secondary, high schools and colleges), different subjects (history, math, science, language learning), problem-solving activities, E-book- based flipped learning, khan academy and mathematics software, academic achievement, learner motivation, self-efficacy, oral performance, student's satisfaction, learning achievement, self-regulated learning skills, academic performance, learning attitude, participation level, student perception, gender and age. The finding of these studies shows respective variances. There were very few numbers of studies that compared the

lecture method with science achievement, scientific attitude and creative thinking of both government and private schools. Though, the review revealed differences and similarities in different instances. It was observed that in the flipped classroom there are very insufficient numbers of studies conducted in the Indian context (especially in Bihar) at the secondary level. however, a substantial number of studies were conducted in abroad focusing on the flipped classroom of school students. Even now comparative studies focusing on flipped classrooms for science teaching of secondary level students of two types of school's government and private were hardly found. There was enough evidence of a knowledge gap regarding school education concerning these variables and covariables. Most of the studies were designed with one type of school either government or private. If there were some studies taken both types of school government and private, though paired methods of teaching flipped classroom and lecture method was not target.

This study in the field of school education both government and private schools is of high significance. Its finding would contribute fresh insight to enhance the quality of school education, increase the student-centered approach, and learn at their own pace. The present study will bridge the knowledge gap in the ongoing trend of research. It enables teachers to overcome with the dilemmatic perception of science teaching, anxiety, and fear of science education from the student's mind. Stakeholders know about the problem of pedagogy of science teaching which is run in school. Know the facts of flipped classroom and lecture method and its prose and cones. Help the teacher by

training them with new methods of teaching and update them with new concepts emerging in the teaching-learning process.

1.10 Rationale for the Study

Science education is very necessary for the development of any country. Due to its importance, it is included in the curriculum. Science education develops the student's ability to think rationally and critically. For the better development of the nation and the country, we need to focus on science education. Science teaching is realized by some instructional procedures like lecture-cum-demonstration, observation, experiment, laboratory, project, hands-on experience, use of multimedia, animation, audio-visual equipment, etc. Through improper and inadequate methods and learning material, we can't achieve the objectives of science teaching. National Council of Educational Research and Training (1961) promotes and conducts educational research experimentation with innovative ideas and practices. It includes curriculum, instructional learning materials, kits, textbooks, training models and strategies, audio-visual and ICT. At the secondary level, it searches the talented students and gives them scholarships to continue his/her study in the field of science and technology. There is a need-to-know what type of learning materials and methods are more effective in science teaching and how can we use them to bring a great revolution in science teaching. All children should be required to take science and math classes as part of general education during the first ten years of school, according to Kothari Commission (1964- 1966) recommendations. This means that it also focuses on science education at the

secondary level. It focuses on classroom situations from the range of evidence in science education. Such a study was scarcely found in during my review, one of study namely Hoshangabad Science Training Project (HSTP) (1972) was the very first program which was started in 1972 by Kishore Bharat and Friends Rural Center, HSTP focused on improving science education from class 6 to 8. It involves learning by discovery through activities and from the environment. It emphasizes the process of science promoting scientific temper and making the child a confident lifelong self-learner and creator of knowledge. In the United State, there is National Science Education Standards (1996), this curriculum examines the standards for scientific instruction and places a strong emphasis on the idea that learning processes have a big impact on what students learn. It has some significant implications in terms of learning material and methods. The National Curriculum Framework (NCF, 2005) this document realized the educational objectives. A teacher can give her current classroom activity direction without separating it from current concerns by using an educational objective to relate it to a desired future outcome without making it instrumental. More students attract in math and science are needed, according to National Knowledge Commission (NKC), in order to revitalize science education and research in the nation. The National Knowledge Commission (NKC) (2009) suggested improving the infrastructure that is already in place, rejuvenating the teaching profession, and redesigning teacher preparation programs at all levels to support this. It means it also influences science teaching with the help of learning material. Justice Verma (2013) advocated child-

centered education and freedom to learn at their own pace, and provision of remedial instruction, non- detention & warm welcoming and encouraging approach. It influences the teacher to play a role as a guide and facilitator. According to the Department of School Education and Literacy of the Ministry of Education, universal access to quality education is a basic requirement for the unity of society and nation, national development, scientific development, and cultural preservation. For which the government has made many plans. Such as Samagra Shiksha, PM Poshan Padhna Likhna Abhiyan, Central Sector Scheme of National Means Cum Merit Scholarship which are committed to create quality education system. Whose special focus is on the marginalized, deprived and underrepresented groups. It is responsible for the development of school education and literacy in the nation. Its main objective is to provide quality education to students by having teachers who are capable of teaching students in new and innovative ways. Be able to use teaching methods according to the nature of the content, the need of the lesson and the subjects. In order to improve the quality of science education, many new methods have been introduced in science teaching, including a flipped classroom, which is a new concept in our country. Related to this very few studies have been done in our country India but many studies related to this have been done in foreign countries, so the researcher chose the research topic related to flipped classroom. UNICEF India's measures education quality and attainment shows that most school children lack basic literacy and numeracy, with additional information and essential skills for all-round development as specified in the

constitution's right to education do not learn. For which UNICEF supports technology and online systems in education. It identifies teaching and teacher quality. and implements strategy accordingly. In India, there have been few studies done on flipped classroom and particularly their impact in science education. From the result of the study, it is expected that the student- center teaching method will do better than the teacher-centered teaching method. It will identify the real and logical effects of flipped classrooms and instructional materials on science performance. There is a lack of empirical evidence on the use of flipped classrooms in teaching methods at the secondary level, whereas there is need to focus on science education specially. According to the Times of India report released by NITI Aayog, Bihar ranks second last in the School Education Quality Index. In 2016-17, according to NITI Aayog data, Bihar recorded a very modest growth of 7.3%. In terms of infrastructure and other facilities, Bihar is second position. The learning outcome of Bihar is 41%. Education Minister Krishna Nandan Parsad Verma said that the state has made a big change in the field of education in 5 years. The special focus of the state is to provide quality education to the students. He further said that we are focusing on many other parameters like teacher quality, cleanliness, hygiene, infrastructure, teaching and learning outcomes etc. This shows that the educational standard of Bihar is far behind compared to other states. In such a situation, there is a need to focus on education and especially science education. From the infrastructure to the quality of teachers, there is a need to look. What kind of teaching method is being used in teaching. It needs to be modernized.

There are many new methods in trends so we also need to see who performs better in these modern and new methods. Therefore, the researcher conducted a comparative study of the very traditional method of teaching but today also used in schools the lecture method and the flipped classroom, which is a very new concept, on the science performance of secondary level students. These specific reasons and situation prompted the researcher to choose such a topic for the study. The proposed study will provide logical evidence of the difference between lecture and flipped classroom. The findings of the study will ascertain the issue of lecture methodology in science teaching at the school level. The results of the study will promote science education through the use of learning materials and allow students to learn at their own pace.

1.11 Research Questions of the Study

We live in a Scientific era so we can't think of a world without science. In recent times there is more emphasis on quality education with science and technology. There is a need to renovate the learning process which enhances the quality of education. Different policies state to use of different innovative methods to develop higher order thinking skills in students. Various learning methods are in trends like the Demonstration method, Discussion method, Project method, Assignment method, online learning, and even conventional mode of learning. Lecture methods are also in trend these days. Flipped classroom are also coming into trend. Our government trained the teacher through online DIKSHA and NISHTHA applications to use different methods for a particular topic or subject. This is an immense step toward the revolution

in the field of education. After various related literature reviews researcher found that flipped classroom is mostly used in a foreign country for different subject and program. But in India, very few studies are found in reference to the flipped classroom. Through the review of research and keen focus on the science of secondary school, some questions emerged as follows which the present study will try the find the answers.

i) Does flipped classroom effects the science achievement?

ii) Does flipped classroom effect the scientific attitude?

iii) Does flipped classroom effect the creative thinking skill?

1.12 Statement of the Study

This study investigates the effect of the flipped classroom on students, and science performance in Biology in comparison to the lecture method at the secondary level of Bihar in Darbhanga town. Hence the study has been entitled **"A Comparative Study of flipped Classroom and Lecture Method on Performance of Science Students at Secondary Level".**

1.13 Objectives of the Study

1) To compare the effect of flipped classroom and lecture method in terms of science teaching at secondary level students on-
    a) Science Achievement
    b) Scientific Attitude
    c) Creative thinking
2) To compare the effect of flipped classroom and lecture method in terms of science teaching on science achievement of-

a) Govt. Secondary level students.

b) Private Secondary level students

3) To compare the effect of flipped classroom and lecture method in terms of science teaching on a scientific attitude of-

   a) Govt. Secondary level students.

   b) Private Secondary level students

4) To compare the effect of flipped classroom and lecture method in terms of science teaching on creative thinking of-

   a) Govt. Secondary level students.

   b) Private Secondary level students

5) To compare the effect of flipped classroom and lecture method on science achievement of-

   a) Secondary level male students

   b) Secondary level female students

6) To compare the effect of flipped classroom and lecture method on a scientific attitude of-

   a) Secondary level male students

   b) Secondary level female students

7) To compare the effect of flipped classroom and lecture method on creative thinking of-

   a) Secondary level male students

   b) Secondary level female students

1.14 Hypothesis of the Study

$H_0$1-There is no significant difference between the science teaching taught through flipped classroom and that of through lecture method on Science Achievement at secondary level students.

$H_0$2- There is no significant difference between the science teaching taught through flipped classroom and that of through lecture method on Scientific Attitude at secondary level students.

$H_0$3- There is no significant difference between the science teaching taught through flipped classroom and that of through lecture method on Creative thinking at secondary level students.

$H_0$4- There is no significant difference between the level of science achievement of Government secondary level students taught through flipped classroom and that of through lecture method.

$H_0$5- There is no significant difference between the level of science achievement of Private secondary level students taught through flipped classroom and that of through lecture method.

$H_0$6- There is no significant difference between the level of scientific attitude of Government secondary level students taught through flipped classroom and that of through lecture method.

There is no significant difference between the level of scientific attitude of Private secondary level students taught through flipped classroom and that of through lecture method.

$H_0$8- There is no significant difference between the level of Creative thinking of Government secondary level students taught through flipped classroom and that of through lecture method.

$H_0$9- There is no significant difference between the level of Creative thinking of Private secondary level students taught through flipped classroom and that of through lecture method.

$H_0$10- There is no significant difference between the level of science achievement of secondary level Male students taught through flipped classroom and that of through lecture method.

$H_0$11- There is no significant difference between the level of science achievement of secondary level Female students taught through flipped classroom and that of through lecture method.

$H_0$12- There is no significant difference between the level of scientific attitude of secondary level Male students taught through flipped classroom and that of through lecture method.

$H_0$13- There is no significant difference between the level of scientific attitude of secondary level Female students taught through flipped classroom and that of through lecture method.

$H_0$14- There is no significant difference between the level of Creative thinking of secondary level Male students taught through flipped classroom and that of through lecture method.

$H_0$15There is no significant difference between the level of Creative thinking of secondary level Female students taught through flipped classroom and that of through lecture method.

1.15 Operational Definitions of the Terms Used in the Study

1.15.1 Flipped Classroom- It is a type of blended learning in which learning is flipped. In this study flipped classroom is used as an independent variable. In a flipped classroom, before class learning material is provided to students in the form of video and text and in-class students are involved in a group activity. Knowledge and understanding level of learning is completed at home and higher order level of learning is completed in the classroom and students ask their doubts to the teacher. During class, students are busy interacting with their peer group and the teacher act as an observer and facilitator.

1.15.2 Lecture Method- In this study lecture method is used as the independent variable. It is an organized form of verbal presentation with question answers and often used charts by teachers to make their lessons easy and understandable.

1.15.3 Science Performance- science performance includes scientific attitude, science achievement, and creative thinking.

1.15.4 Scientific Attitude- Scientific Attitude referred to a mindset of an individual to act in any situation and way of thinking, accept or reject any thing with some degree of favor or disfavor, scientifically and logically solve a

problem, critically evaluate a particular entity, curiosity about nature, patiently observe and broadly think without any other biasness.

1.15.5 Science Achievement- Science achievement refers to obtaining a score on a science achievement test.

1.15.6 Creative Thinking- refers to new and innovative ideas to cope with any situation and problem differently and think uniquely.

1.15.7 Intelligence- it means the rate of success in academic achievement, problem-solving, adjustment and critical thinking ability.

1.15.8 Socio-Economic Status- level of economic difference of parents in the society

1.15.9 Secondary Level- In this study secondary level means IX class.

1.16 Delimitations of the Study

Every research has some limitations because it is impossible to control all the variables, a large sample size, at every level of education etc. Similarly, the present study has some limitations-

- it is limited to only Darbhanga town (Bihar) and at the secondary level.
- It is difficult for researchers to teach all subjects in their experimental study so it is only limited to science, especially biology teaching.
- One Government and one Private school were taken.
- It only checked the science performance (scientific attitude, science achievement and creative thinking).

Chapter -2

Review of the Related Literature

Chapter-2

REVIEW OF THE RELATED LITERATURE

2.1 Introduction

A literature review is an integral part of scholarly research. A content review evaluates what has been published on a topic. It is a survey of scholarly sources that provides an overview of a particular topic. Reviews are more purposeful and important publicity about the topic to provide a comprehensive view of what has been said on the topic and by whom. It helps the researcher to identify the gaps in the research and detail the publication and publication support in the subject. It helps in framing the research problem and understanding the subject area. Reviews tell us about the methods and procedures used by others and if a similar procedure is used by the researcher, they know how well it worked and they can use it for their research. What problems have you faced? Thus, researchers are in a better position to select research methods. Content review is essential to keep your research current. It distinguishes your discovery from others. According to **(Burns and Grove, 2005)** it is a systematic written presentation published by a researcher on a topic. A literature review is a body of writing that seeks to summarize the key findings on a particular study topic **(ANA, 2000).** A content review is an account of what has already been established or published by recognized scholars and researchers on a particular research topic **(University of Toronto, 2001).** There is a post published by recognized scholars and researchers **(Taylor, 2011).** All the definitions above show why a literature review is necessary for any study. It helps

to establish a theoretical framework of your topic or topic area and avoids duplication of research. - A literature review provides a comprehensive look at previous researches and articles related to a specific field and its own research paper. creates a research paper or thesis. It helps to understand different methods of conducting research studies and helps to make the research more relevant and valid. It helps to know how your study adds to the existing literature.

Nowadays science education is being emphasized through various innovative methods and activity-based teaching methods. To check the quality of science education, NCERT (National Council of Educational Research and Training) is conducting several campaigns to encourage students to do better in the field of science by rewarding them for improving their performance in science. Stay. Many researches are being done related to its which is proving to be helpful in promoting science education. The title of the present study "A Comparative Study of Flipped Classroom and Lecture Method Teaching on the Performance of Science Students at Secondary Level" is somewhat similar. And there have been many types of research related to it such as flipped classroom, science performance, scientific attitude, scientific teaching, creativity, critical thinking, problem-solving ability, educational teaching, comparative study with other teaching methods, and different subjects is being done at other levels of education as well. The researcher has tried to include them in the second chapter of his study (review of related literature). In order to include these studies, the researcher has to improve the relevant literature review with the help of various sources like libraries, various journals, online portals, an online portal of various journals, research repositories, doctoral theses,

and national and international journals. An attempt has been made. In the selection of literature sources, empirical studies of educational research, academic abstracts, and printed and electronic doctoral theses were selected. Key Concepts of Article and Thesis Content The flipped classroom. The teaching method and scientific method of teaching have been reviewed. Studies that were sufficiently related to the current study variables, research method and science performance were included. This process largely rejected the literature that was related to science but not related to science teaching and science performance. All reviews are divided into three distinct sections.

Table- 2.1

Detail of total number of researches reviewed

Variables	No. of researches	Duration
Flipped Classroom	39	2012-2022
Science Teaching	8	2014-2021
Methods of Teaching	8	1990-2017
Total	55	1990-2022

Knowledge of the relevant literature enables the researcher to define the boundaries of his field. One's work has explored much of it. But investigators have added so much to knowledge. Relevant studies are included, that is, how the flipped classroom affects the teaching of science, languages, social studies, different professions and different levels of teaching such as elementary, secondary, higher

secondary, college students, etc. The researcher has gone through various sources to review the relevant literature.

Table-2.2

Inclusion and Exclusion for the review

Criteria	**Details**
Year	From 1990 to 2022
Search engines, online and offline journals	Journal of Community Guidance and Research, Journal of Educational Technology and Society, Shodhganga search, Google Scholar, jstor, Edutracks, International Journal of Informative and Futuristic Research, British Journal of Educational Technology, Research gate, Journal of Education and Training Studies, American Journal of Pharmaceutical, The Journal of Negro Education, Journal of Statistics Education, Scholarwork, Johnson renner etc. are search for the reviewed process.
Key words for Search	Flipped Classroom, Flipped learning program, Science teaching, Scientific Attitude and Methods of Teaching, Science Achievement, Creative thinking, Science Education at Secondary Level.
Type of Study	Mostly Experimental researches investigated in Foreign and India were included in this Chapter.

Sample	Mostly school and colleges students were related to science, mathematics, languages, social sciences and different profession.
Publication Type	National and international journals, Doctoral thesis, Articles, and peer-reviewed were included.

2.2 Studies Related to Flipped Classroom

Pierce. Richard, EdD, Fox Jeremy and D. Pharma (2012) conducted a study "Instructional design and assessment Vodcasts and active-learning exercise in a "Flipped Classroom" Model of a renal Pharmacotherapy Module". The "flipped classroom" methodology was put into practice for the renal Pharmacotherapy topic module with the intention of analyzing how it affected the behavior and attitudes of pharmacy students. This study employed a pre-test-post-test experimental design in a lab setting. Range, Mean, S.D., and paired t-test were used to analyze the data, and the results revealed that, when compared to students who completed the same module in a traditional classroom setting the year before, students' performance on the final exam had significantly improved. The flipped classroom teaching style and the action-based guided inquiry learning activity received largely favorable student comments. The renal pharmacotherapy module was taught using the flipped classroom style, which increased student performance and impressions of the educational process.

W. Lisa Johnson, D. Jeremy Renner (2012) conducted a dissertation titled "Effect of the flipped classroom model on a Secondary computer applications

course: students and teacher perception, questions and student achievement". The research question of this study is: How do students' opinions of their educational experiences in regular and flipped classroom settings differ? Does implementing a flipped classroom model increase students' acquisition of Microsoft Office application knowledge? This study's objectives were to assess the efficacy of conventional and flipped course delivery strategies and to look into the advantages, perceptions, and academic outcomes of the flipped classroom approach. The study employed a hybrid methodology. 62 students for the academic year 2010-2011 were selected by the Convenience Sampling method. S.D Mean, ANOVA, and t-test was used to analyze the data and it was found that the mean score of flipped excel unit was the same as the mean score of this class who did not experience the flipped excel unit. Student perception of the flipped experience did not indicate that it changed behavior. Overall, it was found that the flipped method of classroom instruction in a secondary computer application class did not have any advantages.

P. Cheryl Talley and Scherer, Stephen (2013) conducted a study "The Enhanced Flipped Classroom: Increasing Academic Performance with Student-Recorded Lectures and Practice Testing in a Flipped" STEM Course" This study's major goal is to spread the adoption of more efficient learning methods. The study's primary goal was to improve the students' academic performance in the class. The provision of learning strategies applicable to other STEM (Science, Technology, Engineering, and Mathematics) subjects was a secondary objective. The sample for this study consisted of physiological psychology course students. A flipped classroom, practice exams, and self-explanatory learning techniques were

employed in the study to extend the class time and boost student involvement. The data were analyzed using two-tailed t-tests and descriptive statistics. Quantitative research revealed a substantially greater association than in the prior course between the utilization of subject content and students' performance. Qualitative analysis showed that the self-explanatory learning approach was helpful in recalling, retaining and understanding the material. Thus, the use of effective learning techniques, embedded in STEM courses, may contribute to STEM subject retention among African Americans.

Azlina Rahman and Mohmmed Hasnah (2014) conducted a study 2014 titled “The Influence of Flipped Classroom: A Meta-analysis; Approach Every Student Capability in Every Class". Is the flipped classroom suitable for different fields, especially the field of education? This paper will reveal the answer to the question of whether the flipped classroom can be implemented in different subjects, including the type of instruments used to test the effects of the flipped classroom. A total of 15 articles were retrieved from electronic databases such as IEEE, Springer, SAGE Journals, JSTOR, and Pro Quest for previous studies related to the flipped classroom. Based on the results, it was concluded that the flipped classroom has a positive effect on the student’s learning. The flipped classroom was found to be suitable for unifying the various disciplines of science, engineering, technology, and social science.

Szparagowski Raymond. (2014) conducted a study on the “Effectiveness of Flip Classroom”. This research study explores the flipped classroom and its effects on student learning. The primary objectives were to use the flipped

classroom method of teaching high school algebra. To analyze the effect of the flipped classroom on teaching methods to compare flipped classrooms with non-flip classrooms. Non-flipped classrooms ran for 4 days, with normal classroom programs including lectures, activities, and other learning techniques. In the non-flipped classroom, homework exercises cover material covered in class, and in the flipped classroom homework is assigned to watch a 5- to 15-minutes video lecture followed by a 3- to 5-question video. Is there a quiz? During class in a flipped classroom, students engage in discussions, activities, problem-solving, and group work. The researcher used a delta score to analyze the score. In an analysis of homework grades - I found that more students did non-flipped classroom homework than flipped homework. In the non-flipped classroom, about 9 to 10 out of 66 students did not complete their homework every night, whereas the homework grades in the flipped classroom revealed that 19 out of 66 students completed their assignment on the first day, 17 on the second day, and 12 on the third day. The findings suggest that some of the potential benefits of the flipped classroom as a form of education should not be overlooked by teachers.

Ting Hsiu Hung (2014), "Flipping the Classroom to Promote Active Learning in English Language Learners to Foster Active Learning" was conducted. The primary goal of this study was to examine the academic performance, learning attitudes, and participation levels of English language learners. Was there any impact on student's academic achievement from flipping the classroom, utilizing the three lesson assessments as the main gauge? Assessing students' attitudes towards flip teaching? Quasi-experimental design (post-test-only Quasi-

experimental design) was adopted. One Way ANOVA, Post-hoc Tukey test, Mean, Independent sample t-test and SD were used to analyze the data and it was found that the structured flip classroom compared to the traditional classroom was more effective for students learning coursework. Provides better convenience. The difference between structured and semi-structured flipped classrooms was insignificant. Students generally preferred flipped teaching over the traditional classroom.

Sahin. Alpaslan, Cavlazoglu. Baki and E. Yunus Zeytuncu (July 2015) titled “Flipping a College Calculus Course; A Case Study" did a study. How are college students prepared for a calculus class in a flipped classroom? was one of the study's research topics. What are the learning differences between traditional and flipped classrooms for college students? How did college students feel about the flipped classroom concept? Ninety-six (79 male and 17 female) Southeast Texas college students who had taken a mathematics 152- Engineering Mathematics II course participated in the study. The course had ten parts/subjects, of which three were taught flip-style and seven were taught traditionally throughout the semester. The effectiveness of flipped and non-flipped (conventional) sections were evaluated. Descriptive statistics were used to find answers to research questions 1 and 3 and paired t-tests for the second research question. Answers to the first research question revealed that 13% of students were reading books, 35% were watching flipped videos, 18% were reading other texts, 12% were watching other videos, and 22% had no preparation before class. In order to address the second and third study questions, a dependent t-test was used. It was discovered that students

scored much higher on quizzes in the flipped parts than in non-flipped classrooms. According to the comments, the majority of students (83%) felt that the flip classroom part had better prepare them for the rest of the semester's classes. According to the students' replies, the flipped classroom style improved their learning and gave them more self-assurance when learning calculus.

Leis. Adrian (August 2015) entitled a study "A Comparative Study of Flipped and Traditional Classrooms in an EFL Environment". Do pupils in flipped classroom settings outperform those in traditional classroom settings in terms of academic performance? Do students in flipped classroom environments show greater proficiency gains than students in regular classrooms? Independent Sample t-test, Paired Sample t-test and ANOVA were used as statistical techniques and it was concluded that using flipped classroom method increases students' proficiency and students' effort. Flip classroom video with subtitles provided a better understanding of the content.

Özpinar Ilknur, Aydogan Arzu Yenmez, Gökce Semirhan conducted a study **2016)** entitled "An application of flipped classroom method in the instructional technologies and material development course". The impact was to assess students' academic achievement, motivation and student opinions were the aim of study. 50 second-year students studying elementary mathematics education were taken as the sample of this study and Quasi experimental method was used. For quantitative data, we utilized mean, S.D., and t-test; for qualitative data, we used frequency and percentage values. In terms of academic accomplishment and motivation in the experimental group, the results revealed a considerable difference

between the groups. In comparison to pupils who received instruction using the traditional technique, those who studied in flipped classrooms were more successful and motivated.

Zhongger Yu, Guifang Wang (2016) conducted a study on "Academic Achievement and Satisfaction of the Clicker-aided Flipped Business English Writing Class". The objective of the study was flipped classroom better than the traditional classroom in terms of academic achievement and satisfaction. Will the flip business English writing classroom lead to greater academic success and happiness than the conventional one? The researcher hypothesized that the flipped business English writing classroom would lead to better academic achievement and more satisfaction than the traditional one. 69 undergraduate students were randomly selected out of which 34 were male and 35 were female. The study adopted a pretest-treatment-posttest research design. The research instruments used for data collection were a satisfaction scale, a business English written test, and a semi-structured interview. The data was analyzed using means, percentages, and t-tests, and it was discovered that students in flipped classrooms achieved much more than those in traditional classrooms. The hypothesis was accepted since there was a substantial relationship between class type and academic achievement. The flipped classroom approach results in a much better degree of student satisfaction than the conventional approach. On satisfaction levels, the class type had a statistically significant impact. Many students believed that they might get higher academic results using the flipped classroom method, which they felt to be more successful.

Aidinopoulous. Vasiliki and G. Demetrios Sampson (2017) conducted a study "An Action Research Study from Implementing the Flipped Classroom Model in Primary School History teaching and learning". The purpose of the study was to determine whether using a flipped classroom paradigm in a primary school history lesson results in more student-centered activities being done during class time. Does it result in better learning results for students than conventional teaching methods? The main goal of the action research was to determine whether applying the FC model may enhance student learning outcomes and result in more efficient use of class time. The ADDIE methodology breaks down action research into 5 phases: analysis, design, development, implementation, and evaluation. The data were analyzed using the Mann-Whitney U-test, Standardized Mean, and Cohen's d coefficient. It was concluded that the flipped classroom model allows for more efficient use of classroom time. Implementation of the flipped classroom model had a significant positive effect on developing students' historical thinking skills, but not on their ability to recall historical content.

Çakiroğlu. Ünal and Öztürk. Mücahit, (January 2017) A case study "Flipped classroom with problem-based activities: Explanatory Self-regulated learning in a programming language course" was conducted. The study's goal was to help students who were learning in a flipped classroom setting with problem-based tasks improve their SRL abilities. How much did students improve their SRL skills through problem-based learning in the flipped classroom? 30 undergraduate students from the Mechatronics Department of a public university in Turkey were the sample of the study. Through interviews, discussions, and an observation form,

qualitative data were gathered. The five-week experiment was conducted. Algorithms were covered in the first four weeks of F2F education. The data was analyzed using descriptive statistics (mean, percentage), and it was discovered that students employed working techniques more frequently in a face-to-face setting than they did when watching films at home. Both face-to-face and at-home learning helped students enhance their time management abilities in a comparable way. It was discovered that goal-setting, task-planning, and help-seeking abilities were higher in a face-to-face situation. It was found that problem-based exercises in FCM can significantly improve pupils' ability to self-regulate.

Chi. Vivian Wu Wen, Scott. Jun Chen Hsieh and Chi. Jie Yang (2017)

A study on EFL "Creating an Online Learning Community in a Flipped Classroom to Enhance EFL learners' Oral Proficiency". The study sought to determine whether the two teaching approaches had any impact on the participants' spoken proficiency (flipped and traditional). Was there a pedagogical, social, or cognitive difference between the two teaching approaches? What did the participants think of the flipped learning approach to English in general? Participants in this study included 50 sophomores from Taiwan's Central University majoring in English. The data were analyzed using a mixed-method technique. Data were gathered by class observation, a Community of Inquiry (CoI) survey, two semi-structured focus group interviews, and pre- and post-tests of an oral reading and comprehension question. Descriptive statistics and paired sample t-tests were used to analyze the data. The results showed that the mean score of the post-test was higher than the

pre-test. The average score for flipped learning was significantly higher than traditional instruction.

Florence, F L Sophia in (2017) "Teaching Big writing using regular and flipped English classes a comparative study" A study was conducted under the title. The aim of the study was to compare the effectiveness of teaching third grade students Big Writing elements in traditional English classes versus flipped English classes for the experimental group, taking into account the participants' gender. The pre-post design was utilized. For data analysis, statistical methods such as frequency, percentage, mean, standard deviation, median, and t-test were employed. concludes that the experimental group outperformed the control group in terms of performance. In all four major writing categories, female participants outperformed male ones.

Jen-Gwo Hwang and Lin-Chiu Lai (2017) conducted a study on "Facilitating and Bridging Out-of-Class and in-class Learning: An Interactive E-book-based Flipped Learning Approach for Math courses". The research questions were Does interactive e-book-based flipped learning enhance students' learning achievement and self-efficacy compared to traditional video-based flipped learning? The experimental group was given interactive e-book-based flipped learning and the control group was given a traditional video-based flipped learning approach. Data were gathered using a quasi-experimental methodology and a self-efficacy pre- and post-test questionnaire. A pre-test was given to both groups prior to the learning activity, indicating equivalent knowledge, and the post-tests of the experimental and control groups were significantly different. The data were

analyzed using the t-test and ANOVA. Experimental results showed that the suggested strategy considerably boosted students' learning success and sense of self-efficacy. The study also found that interactive e-book technology can benefit students in flipped learning environments and motivates them to acquire knowledge independently.

Lo, Chung Kwan and Foon, Khe Hew (2017) was conducted a study "First Principles of Instruction" to design the Secondary School Mathematics Flipped Classroom: the finding of two Exploratory Studies". The main question of this study was to what extent the use of the flipped classroom affects the mathematics learning of low-performing and high-ability students. The study was carried out in a Hong Kong secondary school. High-performing students took part in a second flipped math classroom, while low-performing pupils were offered a remedial instruction. A pre-test and post-test survey were given out. The data were gathered by a survey approach, and a paired sample t-test was employed to examine them. The outcome demonstrated a statistically significant difference between the pre-test and post-test means. Nearly all students said that using a flipped classroom enhanced their learning and supported its use. The learning of mathematics by both high-ability and low-performing children was improved by this method.

Song Yanjie and Kapur Manu (2017) conducted a study entitled "How to flip the classroom- Productive failure or traditional flipped classroom" pedagogical design". The purpose of the study was to compare the instructional design of a "traditional flipped classroom" with a "productivity failure." In Hong Kong, a secondary school served as the setting for this investigation. A research

methodology known as quasi-experimental research was employed. The data was analyzed statistically using the t-test and one-way ANOVA. The outcome demonstrates that the conventional flipped classroom and production failure groups both enhanced their understanding of mathematics and problem-solving abilities on the subject of "Polynomials," as well as their attitudes regarding their educational experiences. The PFFC group outperformed the TFC group in terms of conceptual comprehension and had a stronger conceptual understanding of knowledge pertaining to "Polynomials."

Zengin. Yilmaz (2017) conducted a study titled “Investigating the use of Khan Academy and Mathematics Software with a Flipped Classroom Approach in Mathematics Teaching”. The objective of this study was to determine the effect of Khan Academy and free open-source software designed in a flip classroom approach on student learning. And the students' views on this approach were to be evaluated. What impact does employing Khan Academy resources and math software in a flipped classroom strategy have on students' progress in the double integral topic? Twenty-eight students, 10 men and 18 women, between the ages of 22 and 26, enrolled in a state institution in Turkey to study mathematics education. An easy sampling strategy was employed. Data gathering tools included an open-ended questionnaire and a self-administered double integral accomplishment test. The data were analyzed using content analysis and the Wilcoxon signed-rank test. According to the findings, student achievement increased as a result of the flipped classroom strategy developed by employing both Khan Academy and math

software. Additionally, it was discovered that using this kind of instruction helped pupils understand and develop their conceptual understanding of mathematics.

Zhai. Xuesong, Gu. Jibao, Liu. Hifu, Chong-Jyh Liang and Chuing-Chin Tsai (2017) conducted a longitudinal survey "An experiential learning perspective on student satisfaction model in a flipped classroom context" and formulated some hypotheses. Student satisfaction in the flipped classroom model is positively associated with perceived quality and perceived values. Prior learning and a personalized learning environment are positively associated with perceived quality in the flipped classroom model. In mainland China, 178 undergraduate students took 32 weeks of English flip lessons. The longitudinal survey structural equation modeling method was used to analyze the research model that was proposed. The following methods were used to examine the hypotheses: chi-square, RAMSEA (the root mean square error of approximation), CFI (comparative fit index), IFI (incremental fit index), GRI (adjusted goodness of fit index), and path coefficient. The hypothesis is supported by the finding that perceived quality is positively connected with both prior learning experience and a tailored learning environment. Value perception is strongly influenced by perceived quality. Perceived quality is unable to accurately predict how satisfied students would be.

Assi Afrah and Anat Cohen (2018) conducted a study entitled "How beneficial and satisfying might a flipped classroom be too high school science education? A comparative case study". The primary objective of this study was to implement the flipped classroom and evaluate overall student satisfaction. In this study, we compared the traditional approach to the flipped classroom to see how it

affected group projects, classroom interactions, and student achievement. For this investigation, both qualitative and quantitative methodologies were employed. The data were analyzed using the SPSS programme and the t-test and Pearson correlation. The outcome demonstrated that, in comparison to the regular classroom, the flipped classroom had a beneficial impact on group projects, social engagement, and improved student accomplishment. This indicates that the flipped classroom is very advantageous and should be strongly suggested in settings where we as teachers hope to enhance student interaction.

Cabi. Emine (2018) conducted a study on the topic of "The impact of the flipped classroom model on students' academic achievement" with the aim of investigating the flipped classroom model on students' academic achievement. This model shows students' opinions about themselves. The research question was to what extent the flipped classroom model affects the academic performance of students. A pre-test and post-test experimental design were adopted for this study. For four weeks, students were taught using a blended learning approach in the experimental group, where the FC model was used, and in the control group, where they were taught using a traditional blended approach. A two-way ANOVA and a 22 split plot design were used to examine the data, and it was found that there was no statistically significant difference between the scores of the two groups. However, the issues with this methodology can be divided into three categories: learning, content, and motivation.

E. Adriana Chis, Moldovan Arghir - Nicolae Lisa Murphy, Pramod Pathak and Cristina Hara Muntean (October 2018), "Investigating Flipped Classroom and Problem-based Learning in a Programming Module for Computing Conversion Course" studied under the title. This study's primary goal was to assess the impact of combining the FC and PBL teaching approaches. Each step of the case study employed a distinct teaching strategy, including traditional, FC, and FC-PBL. Results from the three stages' pre-test and post-test cognitive assessments were analyzed and contrasted. 53 adult students (25 years old) 19.5% female and 80.5% male participated in the study. The case study followed a 9-week learning session in three phases, each phase lasting three weeks. Provided software development module for FC. To analyze the data rank, Mean, Quartile, 1st Quartile, Median, 3rd Quartile, Paired t-test, SD and Mean were used and it was concluded that, the combined FC-PBL technique was statistically superior to those of the conventional and FC approach. In comparison to PBL and traditional learning methods, problem-based learning with the flipped classroom had a statistically significant impact on student learning outcomes. The investigation also showed that the results of learning evaluations using the FC technique and the conventional approach did not differ statistically significantly.

Gillette. C, Rudolph. M and Boredel-Zaugg. K (2018) conducted a study titled "A Meta-Analysis of Outcomes Comparing Flipped Classroom and Lecture" which aimed to examine the evidence for the effectiveness of flipped classroom compared to traditional lectures. This meta-analysis included empirical and Observational studies were included from various sources such as PubMed, ERIC,

and Google Scholar from studies published between 1 January 2020 to 1 July 2017. Random effects model with a weighted mean difference (WMD) was used as the outcome measure. When final exam scores were compared with flipped classroom and lecture-based instruction, no significant differences were found between them. Meta-analysis results show that flipped A lecture may be of less benefit to student knowledge than a classroom. Previous research has suggested that flipped classrooms require more time to develop and implement.

Hua-Hsueh Chuang, Yuan-Chin Weng and Huei-Ching Chan (2018) conducted a study on "Which students benefit most from a flipped classroom approach to language learning". The major goal of this study is to investigate individual factors that may affect learning results in a flipped classroom, such as learner motivation, self-efficacy, and epistemological views. 85 students (10 girls and 75 boys) are investigated in this quantitative study as they learn applied English for vocational education. In order to evaluate the data, hierarchical regression, structural equation modeling, and directional correlations between latent variables were all studied after 7 weeks of flipped classroom instruction, from mid-September 2014 to mid-November 2014. Findings showed that the flipped classroom is most effective for language learners who are highly motivated.

Jen-Chi Lin and Jen-Gwo Hwang in (2018) conducted a study on the topic of "A learning analytics approach to investigating factors affecting EFI students' oral performance in a flipped classroom". The research questions were: Can students' oral performance be improved by an online community-based flipped learning strategy as opposed to conventional video-based learning? Does flipped

learning in an online community have an impact on student engagement? The study's objective was to improve students' oral English proficiency on predetermined subjects and to improve their oral presentation skills and English expression. With a community-based online flipped classroom method, the experimental group of 33 students in the study taught two classes of ELF (English as a Foreign Language), while the control group of 16 students got conventional video training. The independent sample t-test, regression coefficient, and ANCOVA were used to examine the data. The results showed that, in comparison to conventional video-based training, community-based online flipping classrooms can dramatically boost student learning achievement.

Gayathri. H (2019) did a study entitled "Effectiveness of Flipped Classroom strategies on Enhancing learning Performance of Chemistry and in Certain Selected Variables Among the Students of Standard XI". The study's goal was to examine how well flipped classroom techniques could be used to teach class XI students chemistry. to learn the scores that the experimental group and the control group of ninth-grade students received. 3) to assess if there is a performance difference between the experimental group and the control group that is statistically significant on the post-test in terms of (a) whole lessons (b) lessons wise (c) learning objective-wise. The experimental pre-test, -post-test control group study design was used. All students of class XI studying Chemistry in Thoothukudi district were the population, simple random sampling technique was used to select 66 students and each group had 33 students. t-test, ANOVA, two-way ANOVA, ANCOVA, Pearson product-moment coefficient correlation, simple regression

analysis, gain score analysis, and effect size analysis was used as statistical techniques. The analysis revealed that in the experiment, the experimental group outperformed the control group, whole lesson, lesson-wise and learning objective-wise post-test. The achievement ratio of the experimental group indicates that teaching chemistry to XI class students through flipped classroom strategies is more effective than the traditional method.

Irfan Sheema (2019) conducted a study titled "Effectiveness of Flipped Classroom on Learning Outcomes of Teacher Trainee: An Experimental Study" with the aim of studying gender in a traditional classroom and flipped classroom, teaching subject science. And the difference in the arts was to be studied. The researcher chose True Experimental Design for this research. All B-Ed regular students of MANUU, College of Teacher Education Darbhanga were taken as population and all students of B-Ed Ist year 1st (2018-2020) were included as a sample out of a total of 73 students 44 There were boys and 29 girls. Arithmetic Mean, Standard Deviation, and t-test were taken as statistical techniques. On the basis of gender (female and male students), there was a clear difference in the educational results of the post-test of the control and the experimental group, and the average score of the flipped class was found to be better than the average score of the students of the traditional class. A clear difference was found between the learning outcomes of the post-test of the control and the experimental group of the science-based teacher trainees and the average score of the students in the flipped class was found to be better than the average score of the traditional class.

Shaikh Ejaz Ahmed Abdul Quddus (2019) did a study on the "Development of Flipped Learning program for the inculcation of soft skills among secondary school students and its effectiveness". To implement the flipped learning program and to study the effectiveness of the program was the objective and the hypothesis formulated by the researcher was the effectiveness of the flipped learning program in developing soft skills among secondary school students who had participated in the flipped classroom learning program, there would be no significant difference in mean pretest and posttest achievement scores. All secondary school students of Urdu medium from Ahmednagar district were the population. Non-probability sampling was used to select Maulana Azad Urdu Girls High School, Ahmednagar as a sample. To analyze the data, mean scores, Differences in mean scores S.D and Co-relation and coefficient of both groups were used. The mean obtained for the pretest was 119.2 and the posttest was 206.1, the difference between the mean of the two tests being 86.9. The flip program developed by the researcher was effective for developing soft skills. It can further be concluded that the differences found in the post-test are due to the implementation of the flipped learning program which is based on the development of soft skills.

Al-Samarraie, H., Shamsuddin, A. & Alzahrani, A.I. (2020) conducted a study titled "A Flipped Classroom Model in Higher Education: A Review of the Evidence Across Disciplines" which aimed to answer the following questions. Does the use of flipped classrooms have an effect on student learning in university subjects? What are the opportunities and challenges in using the flipped classroom model in these topics? For this research, the researcher took 1621 articles of which

only 85 articles were used for the study. It included 7 subjects Engineering and Technology, Mathematics, Medical and Health Science, Natural Science, Social Science and Humanities, Education, and Arts. A review of previous studies has identified some common opportunities and challenges for the flipped classroom model. Results show that using flipped classrooms, unlike subjects, promote some learning abilities (e.g., engagement, attitude, metacognition, performance, self-efficacy, and understanding). The key opportunity offered by the flipped classroom is to provide students with a deeper understanding of the content and greater control over what and how they learn. The flipped classroom helps students transfer their knowledge between contexts, thereby strengthening their conceptual understanding.

Anabalagan. S (2020) studied "Effectiveness of Flipped Classroom Strategies on teaching in Enhancing Mathematics Achievement Among B. Ed teacher Trainees". The major goal of this study was to determine whether there was a significant difference between the post-test scores and math achievement scores of the B. Ed. trainee teachers in the experimental and control groups. The researcher formulated the hypothesis according to the objective that the accomplishment scores in mathematics of the control and experimental groups do not significantly differ from the post-test scores and gain scores of the B.Ed. certified teacher. The population in the current study are B.Ed.-trained teachers from Tamil Nadu's College of Education, which is associated with Chennai's Tamil Nadu Teacher Education University (TNTEU). To choose 60 respondents, 30 from the conventional group and 30 from the experimental group, the purposive sampling

method was utilized. A pretest posttest nonequivalent group design of a quasi-experimental approach was adopted. The data were analyzed using the following methods: correlation analysis, one-way ANOVA, repeated measures ANOVA, percentage analysis, S.D., skewness, and kurtosis. According to the results, a significant difference was found between the post-test scores of the experimental group's B. Ed trainee teachers (M = 27.50) and the control group's (M = 20.57) B. Ed trainee teachers, and the experimental group's mean mathematics scores (M = 14.73) are higher than the control group's (M = 8.07) post-test scores. So proved that the flipped classroom strategy is better than the traditional one. Additionally, it showed that there was no discernible difference in the post-test attitudes toward mathematics between the experimental and control groups of B.Ed.-trained instructors.

Ghopal Pravin Rameshne (2020) "A Role of Flipped Classroom Teaching Process and its Effect on Nursing Students Knowledge Attitude and Satisfaction" studied. To examine the dimensions of student learning when flipping classroom teaching techniques was the purpose of the study. The researcher expected that there would be a significant difference between pre-test and post-test cognitive scores There will be a considerable discrepancy between knowledge and attitude scores for some demographic characteristics. The pre-experimental single pretest and post-test group designs were taken. 200 students were selected by using purposive sampling. To analyze the data, the researcher used Percentage, Frequency Mean, Median, Mode, S.D and Range as descriptive statistics. And Paired t-test and Chi-Square test were used as inferential statistics. The mean of the

pre-test was 8.80 and the mean of the post-test was found to be 11.965. This showed that the estimate of the mean total between pre-test and post-test is really high and significant and shows a positive relationship between their knowledge and attitude towards depression among nursing students.

Hajari, Bharti in (2020) did a study "A Study of Flipped Classroom Strategy for Enhancing Achievement in Science among Secondary School Students". The aim of this research was to determine whether flipped classroom techniques improve secondary school students' science achievement. Moreover, by using flipped classroom techniques researchers investigate students' attitudes toward studying science. According to the researcher's hypothesis, there is no discernible difference between the experimental and control groups' post-test results on the academic science test questions on metals and non-metals, carbon, and carbon compounds. A quasi-experimental (two-group pre-test-post-test) design was used. The population of this research consists of all eighth-grade pupils enrolled in SSC board schools in Mumbai. 300 pupils from class VIII at the IES New English School in Government Colony Bandra (East) were chosen using convenience and purposively. Data analysis tools included the mean, median, mode, S.D. t-test, and W2 est. From the results, it was concluded that the science achievement of class VIIIth students is positive and definite through the flipped classroom.

Ligi. B in (2020) did a study on "Effectiveness of Flip Teaching on Achievement and Interest in Physics Among High School Students". The study's major goal was to investigate how the flipped classroom affected the physics test

scores of ninth-grade pupils. A pre-test and post-test equal group design was used to complete the study. Each group consisted of 40 students of Standard IX of Higher Secondary School, Krungal Kanyakumari District India, who were equal in terms of intelligence. Paired t-test, S.D, Standard error and ANCOVA were used with SPSS version 2021. The analysis concluded that the experimental group had higher achievement scores in physics compared to the control group at the post-test level, the experimental group had higher achievement in physics with respect to the control group.

LATHA. R (2020) conducted a Study "Effectiveness of Flipped Classroom and Blended Learning on Achievement Science Among IXth Standard Students". The study's major purpose was to establish whether there was a significant difference in the post-test results in computer science between the experimental group (Flipped Learning) and control group (Traditional Learning) of XI standard students. to ascertain the achievement of students in the XI standard in computer science following the flipped learning intervention. A pre-test post-test equal group design was adopted for the study in which 120 students were taken as the sample. Mean, S.D, and ANOVA was used for analyzing the data and the results revealed that the achievement of XI class students in computer science belonging to the flipped learning group was higher after the treatment. It can also be concluded that the flipped learning approach has a positive effect on the achievement of class XIth students in computer science. Flipped learning in computer science has a significant impact on the achievement of XIth standard students in computer science.

Strelan Peter and Palmer Edward (2020) conducted a study titled "The Flipped Classroom: A Meta-analysis of Effects on Student Performance across Disciplines and Education Levels." reporting the first comprehensive meta-analysis of its effects on This meta-analysis included 198 studies and 33,678 students. From the results, it was found that flip classrooms had a moderately positive effect on overall student performance. Despite the flip classroom subjects, it was beneficial.

Zaheer Y. A. Ghafoor (2020) studied "Flipped learning a learner-centered approach to teaching English at the tertiary level" the main purpose of the study was to examine the effectiveness of flipped classrooms in a teaching foundation course in English at the tertiary level in general and imparting reading and listening comprehension skills in particulars. The research question of the study was is the flipped method more effective in teaching English at the tertiary level as compared to the traditional methods. Do the students who are taught the flipped lessons perform better than the students who follow the traditional method? 338 students were randomly selected from the first-year undergraduate students from a college in Chennai. Pre-test post-test experimental design was used and as statistical techniques Mean, S.D, Chi-Square, t-test were used for analyzing the data. From the results, it is clear that reading and listening. The skill can be effectively taught through instructional videos. Students find it more interesting and productive than a traditional classroom. In terms of student performance, traditional and flipped classrooms are very different from one another.

Friesen Times (2021) conducted a study titled "The Effects of the Flipped Classroom Teaching Method: How it impacts Motivation, Performance, and

Satisfaction in the Classroom". The focus of this study was on student motivation, performance, and teacher and student satisfaction. This paper examines how the flipped classroom can be used as an effective instructional tool for classroom instruction. Work processes can be modified but different factors also contribute to motivation, performance, and satisfaction. In this case study, data were collected through interviews and found that in relation to better academic performance, two out of three educators claimed the flipped classroom has undoubtedly improved the measurable success of their students in the classroom. In addition to the classroom's potentially positive impact on motivation, performance, and satisfaction, teachers also attribute other benefits to the flip classroom, including better class time management, increased collaboration and interaction, better retention of content, and better use of technology.

Divijak. Blaženka et al (2022) conducted a study titled "Flipped Classroom in Higher Education During the COVID-19 Pandemic: Findings and Future Research Recommendations." The purpose of this study was to answer the following questions. What are the dominant research views, types of research, and research methods in relevant research to address the use of flipped classroom approaches during pandemics? What is the main outcome of using the flipped classroom approach during the Covid-19 outbreak? The results show that those who used the flipped classroom approach in a face-to-face or blended learning environment were more successful in using it in an online environment than those who had not. This points to the need to examine various initiatives for online delivery of the flipped classroom more comprehensively and with more research rigor.

Ghazizadeh Hashemi AH, Jasim Alsadaji A, et al. (2022) conducted a study titled "The Effect of Flipped Classroom on Student Learning Outcomes; An Overview" This study will review the evidence for the effects of the flipped classroom compared to traditional teaching methods and examine the effects of the flipped classroom on student learning. For this study, the researcher took 699 studies between 2010 and 2022 from Scopus, EMBASE, Cochrane, Web of Science, ERIC, and Medline. The results showed that the flipped classroom is suitable for the Revised Bloom's Taxonomy and has a positive effect on students' learning activities such as academic activity, learning motivation and engagement, social interaction, self-directed learning skills, brain-based learning, case-based learning, multi-intelligence, student understanding, engagement, attitude, and reducing student anxiety. Conclusions: Although the flipped classroom is an effective alternative to teaching and learning, there is not enough evidence to conclude that the flipped classroom has advantages over the traditional approach and that it may be not suitable for the flipped classroom to be effective for each course, teacher, or student.

2.3 Studies Related to Science Teaching

Jagdish, Besapur (September 2014) did a study titled "To Study the Effect of Concept Attainment Model on different abilities of IX standard student's achievement, retention and attitude towards Science". The purpose of the study to determine the effect of concept attainment models on achievement and attitude of science teaching was to be studied. Comparing concept attainment model of traditional teaching on science achievement and attitude among 9^{th}-grade students

and effects of conceptual acquisition model and traditional teaching method on science achievement and attitude among 9th-grade students of girls and boys. A quasi-experimental design (pre-test – post-test experimental design) was adopted for this study. Self-constructed scientific achievement and Avinash Grewal's scientific attitude were used as a tool. Kannada medium schools in urban areas were taken as population. A total of 100 students were chosen, of whom 50 were in the experimental group and 50 were in the control group. Descriptive and correlational analysis was performed to analyze the data and determine the science knowledge and attitudes of the experimental group, which were shown to be higher than those of the control group of students receiving conventional instruction. The experimental group experienced greater increases in science test scores than the girls in the same group. One may argue that the idea attainment model was more effective at boosting performance, memory, and attitude toward science.

Wanjari S.S (November 24, 2014) A study was conducted on the "Effectiveness of Concept attainment model and Inductive thinking model of teaching on student achievement in Science, Scientific Creativity and attitude towards Science". The study's primary aims were to examine the impact of traditional teaching methods and concept attainment models on students' science achievement, scientific creativity, and attitude. to assess how well the inductive thinking model and conventional teaching methods affect students' achievement, scientific creativity, and attitude toward science. A pre-test and post-test nonequivalent group of the quasi-experimental design was used. Purposive sampling was used for the study. Three high schools were randomly selected with

two sections each of class IX. Mean Median, Mode, S.D, t-test, F-ratio, Kurtosis and Skewness were used to analyze the data. Findings showed that the Concept Attainment Model and Inductive Thinking Model of Teaching were highly effective than the Conventional Method inculcating the Scientific Creativity and Attitude Toward Science and Improving the Achievement Among IXth Class students as they have gained more.

Ms. Zakiya Sultana H. ZarZari (2015) investigated a study "A Study the effectiveness of activity-based teaching on academic achievement of 8th standard students in biological sciences". The purposes of this study were to find the measured change in the achievement level of students by cause of activity-based methods of teaching. and to study and evaluate the impact of activity-based methods of teaching on academic achievement due to gender. Shams English Medium High School Bhatkal was selected through a conventional method and a simple random sampling technique was used to select 70 students of the 8th standard of this school as samples. To analyze the data Mean, S.D, t-test, ANOVA, Paired t-tests, and Tukey's multiple comparison test were used. From the analysis, it is concluded that the scores of the 8th class post-test in biological science are different among the study groups i.e., experimental group and control group and similarly among the five activity-based methods of teaching i.e., demonstration method, specimen method, experimental method, microscopic method and structure function method. The post-test academic achievement scores of 8^{th}-grade students in biological sciences were higher in the experimental group of

demonstration method as compared to the control group of demonstration, microscopic, specimen, experimental and structural function methods.

Pandey Rajesh Kumar (2015) conducted a study on the "Effectiveness of advanced organizer and concept attainment model for teaching biological sciences to grade IXth students". The objectives of the study were to study the differences between biological science achievement when taught through the advanced organizer model, conceptual acquisition model, and traditional teaching method. 2) employing the idea attainment model, the advanced organizer model, and the traditional method of instruction, compare the variations in attitudes about biological science. The sample was drawn from the Maharaja Kumar Anant Narayan Singh Vidya Sansthan using the purposive sampling technique. Subjects were matched on intelligence and socioeconomic status. 'F' ratio, Mean and t-test were applied to analyze the data. The interpretation of the data showed that there was a significant difference in means scores of achievements when taught through Advanced Organizer Model, Conceptual Acquisition Model and Traditional teaching. This clearly showed that these different methods have different effects. The conceptual acquisition model is better than the advanced organizer model at the 0.01 level. The Advanced Organizer Model produces a higher mean score of achievement scores and therefore superior to conventional teaching in its impact on student achievement in the biological sciences. Both models are similar in terms of changing students' attitudes towards biological sciences.

Sunil Kumar (2016) conducted a study on "Teaching Biology at Senior Secondary Level through Constructivist Approach. Research question of this study

was "whether constructivist learning approach enhances achievement of students of biology?" The goal of the study is to determine how well constructivist learning strategies (CLS) affect biology student achievement. The researcher's null hypothesis stated that "the mean biology accomplishment scores of the experimental and control group will not significantly change." The researcher chose a quasi-experimental approach (pretest-posttest nonequivalent group design). All 11th grade English medium schools of Gujarat having Biology affiliated to Central Board of Secondary Education were the population. Non-probability sampling method/convenience method was used for sample selection. Self-administered achievement tests and reactivity scales were used to conduct the study. The test ANCOVA, S.D, and Mann-Whitney U were applied to analyze the data and the result found that CLS was found to be effective in significantly increasing student achievement in biology. Constructive learning strategy was also found to be effective in terms of students' positive response towards it.

Dr. N. Anandakumar and Dr. G. Kalaiyarasan. (2017), Conducted a study on “Effectiveness of Web2.0 Technology-based Cognitive Approach in Life Sciences Learning” in December 2017. The purpose of this study is to compare the effect of the traditional lecture method and cognitive approach in biology. A random sample of 60 students from government-sponsored higher secondary schools was chosen, with 30 being assigned to the experimental group and 30 to the control group. The subject material was selected from the XI standard higher secondary syllabus of Cancer Biology. Mean, SD and t-test were used as statistical analysis. After analysis, it was found that the results of the post-test were analyzed

with a statistical method. The cognitive approach is very different from the general approach. Therefore, the cognitive approach was found to be more effective for learning biology.

Lokesh T.N (2019) conducted a study on the "Effectiveness of inquiry training model of teaching or achievement in biology and scientific attitude among secondary school students". The purpose of this research was to who was taught through traditional teaching methods compared to inquiry training model students of scientific attitude and achievement in Biology. To determine whether students' scientific attitude was influenced by gender when they are taught through the inquiry training model. A pre-test and post-test nonequivalent control group of the quasi-experimental design was chosen. 80 Biology students of class IX of Government High School Kallu Nelmangala road Bangalore Chikkabidara were taken as samples. t-test, ANCOVA and Chi-Square test were used for analyzing the data and it was revealed that the inquiry training model is more effective in teaching biology, scientific attitude and enhancing achievement in biology than the traditional method of teaching biology. It had been concluded that instruction of inquiry training model does not create a difference between the experimental group of boys and girls on achievement in biology and scientific attitude.

Patel, Shireen (2021) conducted a study titled "Effect of Co-operative and Mastery learning Approach of Teaching Science in Scientific Attitude and Academic Achievement of Secondary School Students". The goal of this study is to examine how cooperative and mastery learning methods affect secondary school students' academic performance and attitude toward science. The pre-scientific

attitude was taken as a covariate to compare the scientific attitude adjusted mean scores of the students of the cooperative learning method group, mastery learning approach and control group. A pretest-posttest control group of the quasi-experimental design was used. The purposive sampling method was used to select 120 students from Mumbai Public School, Wadala (E), Mumbai. Mean, S.D and ANCOVA were used to analyze the data. The analysis concluded that the Mastery Learning Approach was found to be more effective in improving the scientific attitude of the school student than in the control group where the pre-scientific attitude was taken as a covariate. The cooperative learning method group and mastery learning approach group were found to be more effective but the cooperative learning method was found to be more effective in improving the academic and biological achievement of school students as compared to the control group where pre-academic achievement was taken as a covariate.

2.4 Studies Related to Teaching Method

Murti, K Srinivasa (1990) conducted a study "The Effect of a Creative Teaching Model in Mathematics on the Achievement and the Attitude of IX Class Students". The goal of this study was to assess the program by looking at how it affected students' academic performance and attitude. The null hypothesis said, "There is no significant difference between the experimental and control group's attitude and mathematical achievement." Scores obtained by the Achievement Test, (a test administered by the District Common Examination Board) were taken from school records and student attitudes were taken using the HG Desai tool. Quasi-experimental/inadequate design was adopted. 2^4 Factorial design, ANOVA

Primary ANOVA Orthogonal contrast matrix were used. Data analysis revealed that the creative teaching model improved students' achievement.

Atulkumar Patel Baldevbhai (October 2009) conducted a study titled "Effectiveness of Laboratory Teaching Program on the Achievement of the Students of Standard VIII in Mathematics". The study's primary aim was to examine how characteristics like gender, intelligence, and SES affect achievement, and its other objective was to examine how the experimental (treatment), gender, intelligence, and SES interaction affect students' math achievement. It was expected that major parameters such boys and girls, high and low IQ, and low and high SES group do not significantly differ between the experimental and control group. The researcher created a math achievement exam and a laboratory teaching program. Dr. KG Desai and Dr. H.N. Tapodhan created an IQ test and an SES test, respectively. This study utilized a quasi-experimental approach, and class VIII students and the school were chosen using a purposive sampling technique (220 in number). ANOVA and factorial design techniques were used. After analyzing the data, the researcher found that the laboratory teaching program improved students' achievement in mathematics. No significant difference was found in the achievement of boys and girls. The results also revealed that students in the high IQ and SES group had better achievement than students in the low IQ and SES group.

Shah Gautam. C (2011) conducted a study titled "The effect of creative teaching program on the achievement of the students of standard VII in mathematics". Investigate the major effects of students' gender, IQ, and parental

education on achievement was one of the study's main goals. Additionally, the interplay effects of variables including parental education, gender, and IQ on students' math achievement. According to the hypothesis, "the main characteristics like sex and IQ do not significantly change between the control and experimental group." The tools used in this study were Dr. Jyoti Dev's intelligence test, personality test, questionnaire, interview, sociometry, aptitude test, interest inventory, psychological test, schedule, opinionnaire, rating scale and observation. Standard VII of Gujarati medium schools of Gujarat state were taken as population. A purposive sampling method was used to select schools and students were randomly selected for experimental and control groups. Quasi-experimental design/inadequate design was adopted, ANOVA and factorial design were used as statistical techniques. After analyzing the data, the researcher came to the conclusion that the creative teaching program improved the students' achievement in mathematics. There was no significant difference in the achievement of boys and girls and the high IQ group had better achievement than the low IQ group.

Khandke and Chhaya Gajanan (January 2012) conducted a study titled "Development of text-based Computer Multimedia Software Package for School Students to Enhance their Academic Achievement in Science and Chemistry in Particular- A Study". The main objectives of this study were, to evaluate the performance of the study's computer multimedia software package. to assess the efficiency of the computer multimedia software package vs conventional teaching approach. Purposive sampling was utilized to choose the schools for this study, an experimental research design (pre-test, post-test equivalent group design) was

adopted, and 510 students were chosen as the sample. The researcher created the pre-test and post-test and used mean, S.D, t-test, and percentage as statistical techniques. The results of the study show that using computer multimedia software greatly raises academic performance. When using a computer multimedia software package instead of the conventional methods of teaching and learning, the experimental group outperformed the control group of standard VI pupils on the post-test for that standard.

Reshma Achary (2015) studied under the title "Effectiveness of Constructivist Approach in Teaching Physics to Mechanical Engineering Students at Diploma Level". The major goal of this study was to evaluate the effectiveness by contrasting it with traditional approaches. The study's methodology was pre-test intervention-post-test quasi-experimental. The purposive sampling method was used to select 60 students of Butler Polytechnic College affiliated with Gujarat Technological University. To analyze the data, t-test and ANCOVA were used to determine the effect of the intervention program. After analyzing the data, it was concluded that the students of the constructivist approach used to teach physics obtained more scores than the students of the control group. And also, the constructivist approach increased students' retention of learning over time.

Dr. F. Deepa (2016) conducted a study of "Effectiveness of e-Learning on Pupils' Achievement in Mathematics at High School Level". This study's objective was to assess how e-learning affected the mathematical achievement of high school students. This study used an experimental research design (two group pretest/treatment: post-test experimental design) was taken for this study. The

purposive sampling method was used to select 50 students of IXth in Raja Higher Secondary School of Thanjavur district, Tamil Nadu. Achievement Test in Mathematics was developed and standardized by the researcher. An e-learning package for the unit 'Coordinate Geometry' was used to teach the experimental group. Mean, SD, t-test and F-test were used to analyze the data. The result showed that e-learning was more effective in teaching mathematics than the traditional method.

Dr (sr.) Leonilla Menezes A.C. (2016) conducted a study on "Effect of Multimedia Approach on Developing Self-directed Learning and Achievement among Secondary School Pupils". The main goal of this study was to ascertain whether there was a significant difference in the experimental group's mean self-directed learning and achievement scores between the pre-test and post-test. whether there is a discernible difference in self-directed learning and achievement scores between the pre-test and post-test. In this experimental study, the investigator used a non-randomized control group pretest-posttest design to study the effect of instructional materials. Secondary school students of the South Kannada district of Karnataka state were part of the population. The purposive sampling technique was used to select 80 students of the 9th standard. Self-constructed tool, self-directed learning and achievement and a verbal test of creativity by Baqer Mehdi were used. The researcher used the t-test Co-efficient of Co-relation, Mean, S.D, and ANCOVA as statistical techniques for data interpretation. The researchers came to the conclusion that the multimedia method is successful in fostering achievement and self-directed learning skills. Throughout

the study, it was observed that instruction with the use of text, images and audio accelerates learning and positive outcomes can be expected as a result.

Shobhana Nair Nandkumar (2017) conducted research under the title "Impact of new trends of the teaching-learning process in mathematics towards the competitiveness of female students at higher secondary schools in Mumbai" with the aim of this study to investigate how new trends in mathematics teaching and learning affected female pupils. female students in mathematics. The new trends in teaching mathematics were to be studied. To find out the relationship between the learning behavior of students of eleventh and twelfth standard female students studying in aided and unaided junior college. Maharashtra State Board of Higher Secondary students were taken as the population. To choose the sample, random probability sampling was utilized. The data was analyzed using the t-test, Mean, SD, chi-square, and z-test, and it was discovered that new trends have a substantial impact on how well female students in higher secondary schools learn mathematics. Higher secondary schools are significantly influenced by new trends, according to 83.4% of female students and 16.6% of male students in the survey.

2.5 Summary of the Review of the Related Literature

The review of related literature on the variable's science achievement, scientific attitude and creative thinking at secondary level students is justified, in which numerous aspects are identified, including different theories, nature, factors of variables, a tool used, related design and statistical techniques are included. It helps the researcher to develop a framework, formulate hypotheses, and research questions and select variables and covariables to confirm the information obtained

in the study. Based on the variables discussed above, the analytical and critical observations of the review of the relevant literature are in this chapter. They give different results due to variance in study design, subject, teaching level, etc. When we review previous studies and try to find out how the flipped classroom affects students' science performance (science achievement, scientific attitude and creative thinking). Some studies have shown that flipped classrooms have different effects compared to variables, levels of education, different subjects, courses, and other teaching methods. This model was mostly positive. The academic performance of flipped classroom students is better than those taught by traditional methods Zohagger Yu, Guifang Wang (2016). The gain ratio of the experimental group indicates that teaching chemistry to eleventh-grade students through flipped classroom strategies is a more effective method compared to the traditional method. Gayathri. H (2019). Does the flip classroom affect science achievement and attitude, Anabalagan. S (2020) conducted a study on attitudes toward mathematics and achievement and found in his research that classroom strategies positively modulated achievement in mathematics. However, there is no discernible difference in the experimental group's attitude toward mathematics compared to the control group. Additionally, Hajari. Bharti (2020), conducted a study and reported that the flipped classroom strategy had a definite, better effect on eighth-grade students' science achievement and Ligi.B (2020) also found that the flipped teaching group achieved more in physics than the control group. A similar study was conducted by Zaheer Y. A Ghafoor (2020), on whether it works on student performance, and found a significant difference between traditional and flipped

classrooms on student performance. In the process of review, the researcher found that various studies have been conducted on science education. According to the topic, the researcher selected some studies of general variables such as science achievement and attitude towards science. Jagadesh. Besapur (2014) conducted a study on science achievement and attitude and found that the experimental group that was taught by concept attainment model had higher science achievement and attitude than students taught by the traditional method. Furthermore, Pandey Rajesh Kumar (2015) conducted a study on biological science and found that the effect of the conceptual attainment model and advanced organizer model was superior to traditional teaching on student achievement in biological science. Sunil Kumar (2016) conducted a study on science teaching and found that constructivist learning strategies were found to be effective in significantly increasing student achievement in biology. Dr. N. Anandkumar and Dr. G. Kalayiarasan (2017) found a cognitive approach highly deviated from the normal method. The cognitive approach had higher effectiveness for biology learning. Lokesh T.N (2019) and found inquiry training model is more useful in teaching biology were more effective for enhancing achievement in biology and scientific attitude when compared to the conventional method of teaching biology. Patel Shireen (2021) conducted a study on science teaching (cooperative learning method and mastery learning approach) and found that cooperative learning was more effective in improving achievement in biology of school's student than the control group while mastery Learning approach is more effective in improving scientific attitude of students. There are several studies related to teaching methods on different subjects are also included

as a review of this chapter. Researcher found mostly better teaching methods work better on students' performance, achievement, academic achievement, attitude and creativity whether in science or social science, languages, math and computer courses. Few studies contradict the findings of the above studies such as Cabi Emine (2018) conducted a study of the effects of flipped classrooms on student achievement and concluded that two groups of flipped and traditional blended learning scores had no significant difference. There was no difference. E. Adriana Chis, Moldovan Arghir-Nicolae Lisa Murphy, Pramod Pathak and Cristina Hara Muntean (October 2018) In the programming module of a computing conversion course, looked into a flipped classroom and problem-based learning. The outcome demonstrates had no statistically significant difference between the traditional method and the flipped classroom approach in terms of the outcomes of the learning assessment.

2.6 The present study

In the Summary of the review of the related literature, there was hardly any study conducted at the secondary level to compare the variables like science achievement, scientific attitude and creative thinking through flipped classroom and lecture method in dual types of schools (Government and Private). There was enough evidence of a knowledge gap regarding flipped classrooms on science teaching with respect to these variables. Most of the studies were done on single school and one type of school either government and private. The present study in the field of science education at the secondary level through flipped classroom did not find the population of Darbhanga City (Bihar). The subjects of science

especially biological science and the variables of creative thinking have not occurred in the review through the flipped classroom. So, the researcher will try to fill this knowledge gap to do the present study.

Chapter- 3

Research Methodology

Chapter 3

DESIGN OF THE STUDY

3.1 Introduction

The human being is very curious by nature and their curiosity is immeasurable. Researches satisfy human curiosity. Research is a formal, systematic and scientific process. Researchers examine the goals and document carefully monitored findings that might result in the formulation of generalizations, principles, or theories. According to the study, "research is thought of as a more formal, methodical structure of investigation that usually culminates in some sort of formal record of operations and reports of results and conclusions." (Best, 1990). To complete any research paper, research methodology is very significant. It is a method for methodically resolving a research problem. It outlines the research process and provides a work plan for conducting research. Research methodology describes the specific procedures or techniques used to locate, select, compile, and analyze data on a subject. The reader can critically assess the overall validity and reliability of a study by reading the methodology chapter. Clarify the research process, including how data was gathered and analyzed, and how it was done scientifically. Research methodology is a broad area compared to research methods. Research methodologies are the tools you employ when conducting research. It serves as a representation of the tools of the trade and explains how to gather and evaluate data in order to draw certain conclusions, discoveries, and generalizations. But research methodology defines how to apply a particular technique and which

technique or methods are relevant or not. It explains the rationale behind any research techniques we utilize in our study and explains why we choose to use a specific approach and methodology while avoiding others.

The details are described under the following major heads-

Design of the study

Variables of the study

Description of tools

Conduction of experimental research

Administration of tools

Analysis of data

Statistical technique

3.2 Design of the study

The general plan of your research is referred to as the research design. The study's design explains the type of research design you employed. It serves as the blueprint for data gathering, measurement, and analysis. The sort of design is determined by the research problem. According to Miller, "research design" refers to the organized process of every step required in carrying out a research investigation.

Johoda, Deutsch and cook have defined it as “A research design is the setting up of parameters for data collection and analysis with the intention of balancing procedure economy with relevance to the research's goal”.

A study's design identifies the type of study (descriptive, correlational, experimental, historical, longitudinal case study, etc.) as well as the research

question, hypothesis, independent and dependent variables, data collection strategy, and statistical analysis strategy. Generally, there are two types of research design non-experimental and experimental design. The present study was "A Comparative Study of Flipped Classroom and Lecture Method on Performance of Science Students at Secondary Level" experimental design was suitable for this study.

An experimental design is quantitative. In an experiment control and manipulate the independent variables and compare them with dependent variables. In experimental research, establishing a causal link between the dependent and independent variables is the main objective. A scientific method of conducting research called experimental research involves manipulating one or more independent variables and observing the effects of those manipulations on one or more dependent variables. It is common practice to watch and record how the independent variables affect the dependent variables; this is similar to an observation made under carefully controlled circumstances. Experimental research offers a great deal of control and creates a logical and methodical link between the changed variables and the results that are seen. In experimental research, hypotheses are accepted or rejected in light of the observed relationship of the controlled variable. In the humanities and social sciences, experimental research does not follow a precise research methodology. due to the complexity of humans and the need to control extraneous variables. Apart from all these difficulties experimental research plays a great role to solve educational problems. Through the measurement of their results, experimental

research identifies and assesses the suitability and efficacy of the educational and instructional objectives. After assessing the goals and putting the hypothesis to the test, its suggestions, findings and conclusions help to execute and modify the educational programs, teaching methods, classroom practices, educational planning, curriculum development, examination process, innovation in the evaluation techniques etc. The classroom teacher, principal and headmaster of the institution, block education officer, trainee teachers, and other educational practitioners used the suggestions of experimental research and modify their planning in a better and more feasible way.

3.2.1 Definition of Experimental Research

"An experiment is an observation made in a predetermined environment". **F.S. Chapin**

"Under carefully monitored conditions, experimental research is the description and study of what will be or what will occur." **John W. Best**

"The hypothesis is provided by the experiment, which studies the causal relationships between two facts." **Green Wood**

"Observing the effect of the manipulation of an independent variable on a dependent variable may be described as the essence of an experiment." **Festinger**

An experimental design is just like a blueprint for an architect. With the aid of statistical data analysis, it helps the researcher to give the study's findings a meaningful interpretation. The aim of the experiment's objectives and the kinds of variables to be manipulated are used to determine which design should be

used. The design deals with a practical aspect of conducting experimental research i.e., how to divide participants into experimental and control groups, how to modify and control variables, how to control unrelated variables, how to record observations, etc. Selecting an appropriate experimental design and conducting experimental research is very important. Appropriateness is the chief criterion for selecting a design and testing the hypotheses. The study's results will be useless if the design is irrelevant and improper. In order to gauge how the independent variable affects the dependent variable, adequate control is also crucial. A reliable answer can be obtained by the researcher with sufficient control over unimportant variables. The validity of the design is crucial for the evaluation of the specific hypothesis. Pre-experimental, quasi-experimental, and true experimental designs are the three main categories of experimental design.

3.2.2 Pre-Experimental Design

It has been further categorized into the following designs- One Shot Case Design, One group Pretest Posttest Design.

3.2.2 (a) One Shot Case Design

3.2.2 (b) One Group Pre- test Post- test Design

3.2.3 Quasi Experimental Design

In this design, there is no random assignment possible and have no full control over the experimental condition. It is very necessary to know which of the variables have failed to control in this design. This design has more emphasis on external validity and is low on internal validity. It is an

intermediate between co-relational study and true experimental design. The Independent variable is manipulated but subjects are already a group of the experimental and control group. A quasi-experimental design is more suitable for social sciences studies because they are more practical and feasible to conduct research. It is easy to conduct due to the lack of randomization that can be performed in a natural setting. The following are the important quasi-experimental designs:

3.2.3 (a) Nonequivalent Control Group Post-test Only Design

3.2.3 (b) Nonequivalent Control Group Pretest- Posttest Design

3.2.3 (c) Time Series Design

3.2.3 (a) Nonequivalent Control Group Post-test Only Design

A dependent variable is evaluated after the therapy has been given to one group, and the researcher compares the outcomes to a non-equivalent control group that did not get the treatment. Although the participants in the non-equivalent control group are not randomly selected to receive the treatment, they have many of the same traits as the treatment group.

Table 3.1

Nonequivalent Control Group Post-test Only Design

Group	Independent variable	Post-test
Experimental group	Treatment	T_1
Nonequivalent control group	Controlled condition	T_2

3.2.4 True Experimental Design

True experimental design further divided in to followings-

3.2. 4 (a) Post-test Only Design

3.2.4 (b) Pre-test- Post- test Design

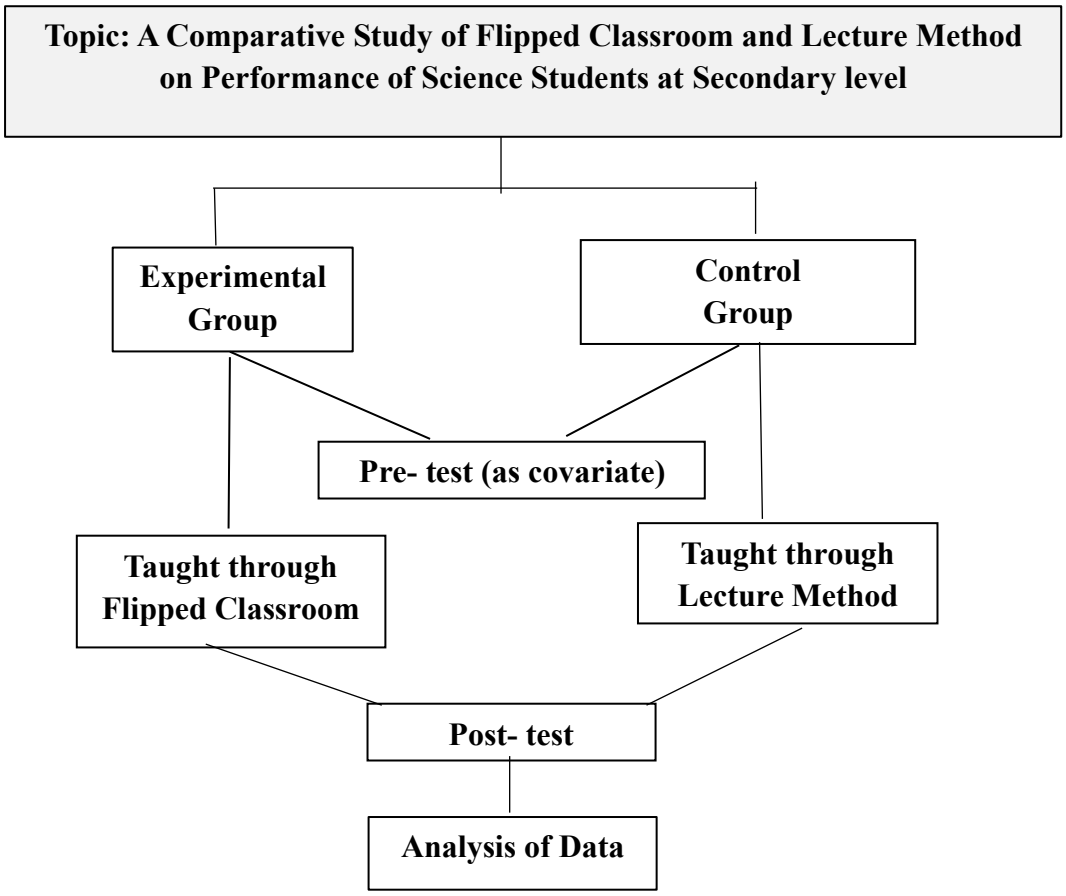
3.2.4 (c) Solmon Four- Group Design

Design of the Study

For this research, a topic researcher has chosen the quasi-experimental design (Nonequivalent Control group post-test only design**).** Following has the flow chart of the research design.

Figure3.1

Design of the Study



3.3 Variable of the Study- It **is** characteristics, perceptions and concepts which vary and can be measured in research. Variables play a key role in qualitative and experimental research.

3.3.1 Definitions of Variable

In **Kerlinger's** words, A variable is a trait that can have various values. A symbol with connected numbers or values is referred to as a variable.

Measurable or observable characteristics or traits of an object, person, or organization that are different for each of the subjects being examined **(Creswell 2002).**

They have values and levels (the varying dimensions) **(Sommery 1997).** The independent and dependent variables are crucial for this study.

3.3.2 Independent Variable

The independent variables are the elements or features that the experimenter modifies or regulates to determine how they relate to the observed occurrences (Best, 2006). For this study, learning materials for secondary school student's performance in science were created by the researcher for a flipped classroom. As a result, the study's independent variables were the teaching styles (Flipped Classroom and Lecture approach).

3.3.3 Dependent Variable

It is also known as an outcome or predictor variable. The conditions or qualities that the experimenter inserts, eliminates, or modifies as independent variables are known as dependent variables. **(Best, 2006)**. In the present study

science, and performance (science achievement, scientific attitude, and creative thinking) were the dependent variable of this study.

3.3. 4 Attribute Variable

The attribute is made up of traits that the researcher cannot change. either it includes or is excluded as a variable in the study such as age, sex, race, intelligence level, etc. In this study type of schools based on school management (Government and Private schools) and gender (male and female) were attribute variables.

3.3.5 Covariate/ Extraneous Variable

It is an unpredictable variable. While the researcher cannot control this variable, the findings of the study may be affected. Particularly in studies conducted in classrooms, it is impossible to completely exclude all irrelevant variables. The socioeconomic situation of the students and their degree of intellect were taken into consideration as covariate factors in the current study.

3.4 Population and Sample of the Study

3.4.1 Population

Any collection of people who share one or more traits is referred to as a population by researchers**. (2006) Best & Kahn**

The population of the present research was the total students (Government and private schools) at a secondary level of Darbhanga town of Bihar.

3.4.2 Sampling Method

"A sample is a subset of the population that is chosen for observation and study. Looking at the characteristics of the sample allows one to make

inferences about the characteristics of the population from which it was taken". **(Best, Kahn, & Jha 2018).** The present study researcher selected both government and private schools through non-probability (conveniently). For the government school, she has chosen the B.K.D Zila high school Darbhanga and considering the private school researcher elect the Salfia school Darbhanga. The sections were randomly assigned to the control and treatment groups.

3.4.3 Sample

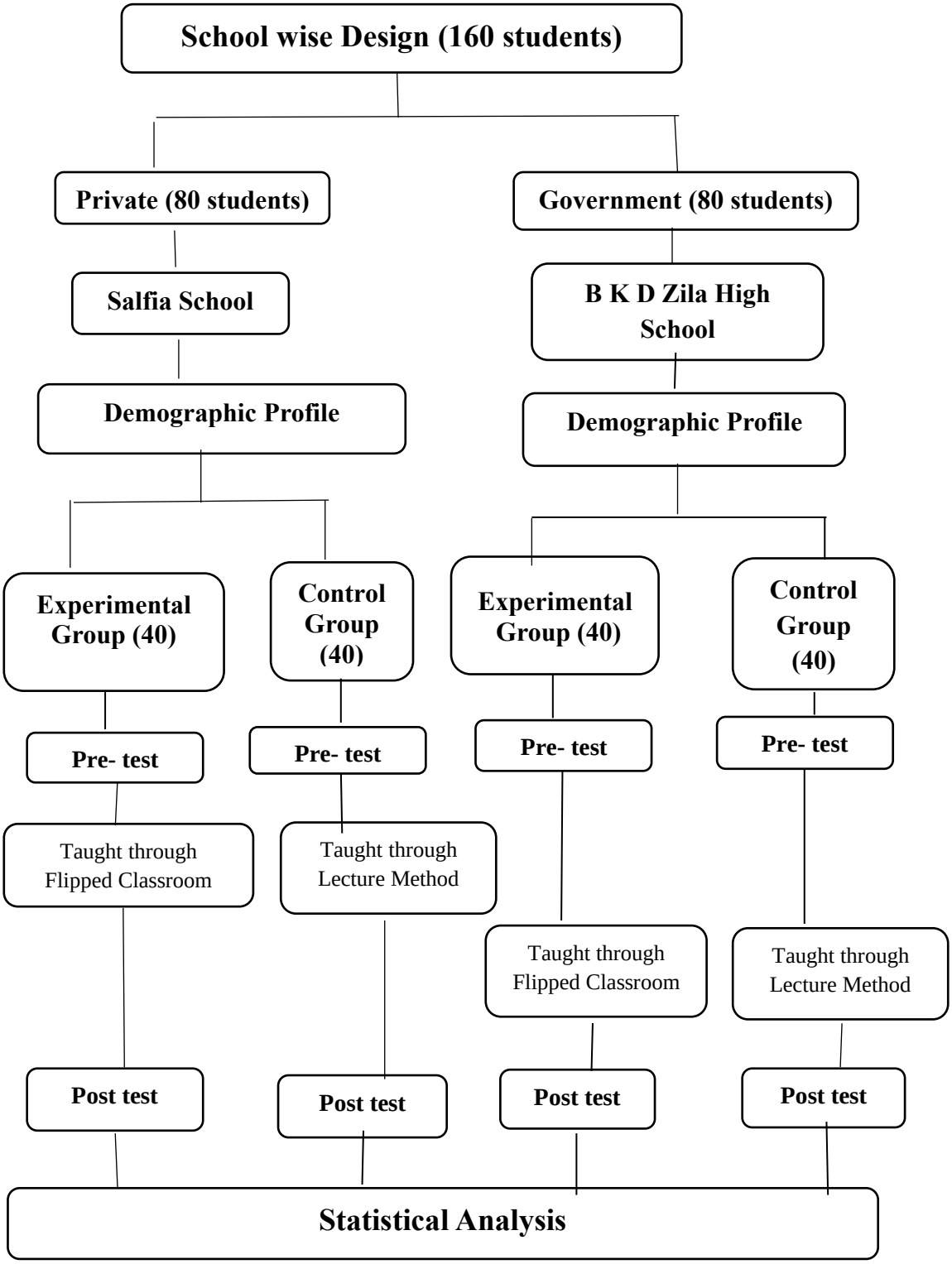
For this study, all those students who were present in the IXth sections of chosen schools are made the sample of the study.

3.4.4 Sample Size

Sample size of the study was 160 which were taken from both schools, 80 students from government (B.K.D zila high school) and the other 80 were students from private (Salfia School).

Figure 3.2

Flow Chart of the Experimental Design with sample size of the study



3.5 Tools Used in the Study

Tool-it is a testing device that measures and gathers information for data analysis and interpretation. The tool is the instrument that measures the all information from the sample according to the needs of our research. According to the nature of the information, we use different types of tools like questionnaires, interview scales, checklists, observation schedules, rating scales etc. It is used for data collection and constructed by researchers and experts. The following tools were used in this study:

(1) The socioeconomic status scale by Alka Saxena and Sunil Kumar Upadhyay (2011)

(2) Group test of General mental Ability by S.S Jalota

(3) Verbal test of Creative thinking by Baqer Mehdi

(4) Scientific Attitude Scale: The researcher developed this rating scale to assess the pupils in the IXth grade's scientific attitudes.

(5) Science Achievement Test: The researcher develops and standardizes an objective question format, such as multiple-choice questions, to assess the science achievement of pupils in the IXth grade.

3.5.1 Socio-Economic Status Scale

Alka Saxena and Sunil Kumar Upadhyay created the test (2011). The socioeconomic status of students in urban and rural locations is measured by the current scale. There are 31 elements in all, divided into five categories: personal information; (ii) family; (iii) education; (iv) income; and (v) other (Cultural and material possessions). The selective type has been used to frame the items, offering 2 to 7 options.

Reliability of the test- Test-retest reliability was found to be 0.83.

Validity of the Test- Test validity was calculated by connecting with Shah's SESS in 1986 and was discovered to be 0.73.

Norms of the Test- For norms researcher classify the scores and describe them in the category of socioeconomic status.

Table- 3.2

Classification of Scores

Category	Scores
High	75 or above
Above Average	Between 62 to 74
Average	Between 49 to 61
Below Average	Between 36 to 48
Low	35 or below

3.5.2 Group Test of General Mental Ability

The test was developed by S. Jalota. it is a point scale for adults. It has 100 objective questions related to mathematical reasoning, general Hindi, mental ability tests etc. Each correct response carries one mark and the wrong answer zero.

Scoring- Conversion of the score into Mental Age- the total score of the respondent is equal to the total correct answer. Convert the total score into mental age with the help of table 3.3, for each score corresponding to mental age in the years and month that has been given.

Converting Mental Age into I.Q

1. Convert Mental Age into Months (Years×12+Months) = MA
2. Convert Chronological Age into months (Years×12+Months) = CA
3. IQ = MA/CA×100

Table- 3.3

Conversion of Score into Mental Age

Score	Mental Age Yrs.- Mo	Score	Mental Age Yrs.- Mo	Score	Mental Age Yrs.- Mo
00	00-00	35	11-10	70	18-10
01	3-6	36	12-00	71	19-00
02	3-9	37	12-2	72	19-3
03	4-00	38	12-4	73	19-5
04	4-3	39	12-6	74	19-7
05	4-6	40	12-8	75	19-10
06	4-9	41	12-10	76	20-00
07	5-00	42	13-00	77	20-2
08	5-2	43	13-3	78	20-5
09	5-5	44	13-5	79	20-8
10	5-7	45	13-7	80	20-10
11	5-10	46	13-9	81	21-00
12	6-00	47	14-00	82	21-3
13	6-3	48	14-2	83	21-5
14	6-6	49	14-4	84	21-7
15	6-9	50	14-6	85	21-10
16	7-00	51	14-8	86	22-00
17	7-2	52	14-10	87	22-2
18	7-5	53	15-00	88	22-5
19	7-8	54	15-3	89	22-8

20	7-10	55	15-5	90	22-10
21	8-00	56	15-7	91	23-00
22	8-4	57	15-9	92	23-3
23	8-8	58	16-00	93	23-6
24	9-00	59	16-3	94	23-8
25	9-4	60	16-6	95	23-10
26	9-10	61	16-9	96	24-00
27	10-00	62	17-00	97	24-3
28	10-3	63	17-3	98	24-6
29	10-6	64	17-6	99	24-9
30	10-9	65	17-9	100	25-00
31	11-00	66	18-00		
32	11-3	67	18-3		
33	11-5	68	18-5		
34	11-8	69	18-7		

Table- 3.4

Classification of I.Q. into Levels

Sr. No.	Range of I.Q.	Levels
1	151 & above	Genius
2	131 to 150	Very Superior
3	121 to 130	Superior
4	111 to 120	Bright
5	90 to 110	Average
6	81 to 89	Low (Slow learning)
7	71 to 80	Dull
8	46 to 70	Very Dull
9	45 & below	Mentally Retarded

3.5.3 Verbal Test of Creative Thinking

Baqer Mehdi was the one who created the test. It is a verbal creative thinking test that consists of four subtests (activities), including the tests of consequences, unique uses, resemblance, and product improvement. Fluency, flexibility, and originality are the three qualities that each of the test's ten items must meet.

Reliability of the Test- Test-retest method was used to reliable the test.

Table 3.5

Reliability Testing of the Factor Scores and the Total Creativity Score (N=31)

Fluency	Flexibility	Originality	Total Creativity Score
.945	.921	.896	.959

Validity of the Test- Users of the exam can feel confident using it because the validity coefficients for the factor scores and the overall creative score are strong enough (Sig. above the.01).

Table 3.6

Factor Score Validity Coefficients Against Teacher Rating (N=300)

Fluency	Flexibility	Originality	Total Creativity Score
.40	.32	.34	.39

Beyond the.01 level, all associations are significant

Scoring- Each answer will be graded on its fluency, flexibility, and originality.

Scoring of Fluency- irrelevant and repeated responses were not considered - An unrepeated idea has been expressed only once under a given problem was considered.

Scoring of Flexibility- it considers only the categories of ideas. For if out of six responses given by the testees of an item. If every notion falls inside a single category of thought, the flexibility score will be 1. However, if all six concepts were based on six distinct ideas, the flexibility score would be 6. And if 2 ideas belong to one category of thought, 1 belongs to a different category of thought and 3 ideas will be in the same category of thought the flexibility rating will be 3.

Scoring of Originality- The basis for scoring originality is the response's statistical rarity. A response will receive an originality score of 5 if it was provided by 1% to 99% of test takers; if it was provided by 1% to 1.99% of respondents; it will receive a score of 4; if it was provided by 2 to.299% of respondents; it will receive a score of 3; and so on. However, if 5% or more of test takers responded, the originality weight would be 0.

3.6 Procedure for Construction of Tools

3.6.1 Scientific Attitude Scale: Rationale:

To select the study's variables, the researcher looked through a variety of reviews of pertinent literature, theses, and a database of psychological tests to find a tool to gauge secondary school students' attitudes about science. The researcher chose to create a tool for the current investigation after failing to locate an appropriate tool to assess the scientific mindset. The rating scale was

discovered to be the most suitable for building the tool after the researcher researched various types of attitude exams. According **to Barr, Davis, and Johnson, (1993)** "a rating scale is a phrase to applied to the expressing of opinion or judgment of specific circumstances, items, or characters". Psychological elements such as beliefs, principles, and perceptions, among others, influence a person's attitude. Each of these plays a nuanced part in figuring out someone's mindset. Values are ideas that serve as a person's guiding principles or ultimate objectives **(Maio & Olson 1998)**. In psychology, an attitude is a mental and emotional phenomenon that resides in or defines an individual. It is intricate and learned via practice. It is a state of mind, how we react, what is our perception regarding the value, what is our expression against a person, place, things, events, activities, ideas and traditions. Attitude is based on our feelings, and emotions It can be positive or negative. An attitude is "a psychological inclination that is represented by judging a particular entity with some degree of favor or dislike," according to Eagly and Chaiken. science promoting our life either directly or indirectly. According to Grinnel," scientific attitude is not an approach to solve the world's problems, but a way of viewing the world" Jung's definition- is "psyche's readiness to act or respond in a particular way". Developing a scientific attitude is a general aim of science education. **Education Policies Commission (1966)** labeled the scientific attitude as "the spirit of science". It can be measured by using different scales and techniques. Similarly, the scientific attitude is the way of thinking

reasonably, logically and clearly without any prejudices or preconceived notions.

3.6.2 Construction of the Scientific Attitude Scale

According to Thurstone, an attitude refers to the level of positive or negative emotion connected to certain psychological items. Concept attitude is defined as "the totality of a man's tendencies and feelings, prejudices or bias, thoughts, and rears about any certain topic."

Before the construction of the scientific attitude scale, we discuss and study in brief the meaning, characteristics, types, advantages and disadvantages of constructing the Likert type scale for the present study. It contains several items, that have been just as attentively edited and selected. Items on this attitude scale are called a statement. For standardizing the scale researcher is required to react with an expression of approval or disapproval or agreement or disagreement with each statement or item and the whole scale.

3.6.3 Type of Attitude Scales

Generally, we use the following method

1. Thurstone’s Scale
2. Likert’s Scale
3. Guttman’s Scale
4. Bogardus’s social distance scale

3.6.4 Likert Scale

It gauges public sentiment toward a subject. A Likert scale with an interval response option, in academic parlance Ordinary measures, dictate that the questio ns are presented from one extreme to the next. Numbers indicate the relative position of items, but not the magnitude of difference. Various rating scales have been created to directly measure attitude, including A five- or seven-point scale that enables the respondent to think about how much they agree or disagree with a given statement is the fifth and final form of Likert scale. Inferring that the degree or strength of an attitude is linear, that is, on a continuum from strongly agree to strongly disagree, a Likert scale posits that attitudes can be evaluated. Despite the disagreement, the Likert scale can be used to assess various variations, including frequency, quality, importance, and statement likelihoods.

3.6.5 The following steps were performed by the researcher to create the scientific attitude scale:

3.6.5.a Construction of items

3.6.5.b Preparation of initial draft

3.6.5.c Evaluation of initial draft

3.6.5.d Item analysis

3.6.5 e Preparation of the final draft

3.6.5 f Method of scoring.

3.6.5.a Construction of Items

-Items were constructed using real-world examples from education, society, and the environment.

-Double negative items were avoided

- Items were written in simple and clear language (English and Hindi)

- Items were written according to the age and school level of students.

- Long and bothering items were evaded.

-Items containing measures of Strongly Agree, Agree, Undecided, Disagree and Strongly disagree.

3.6.5.b Preparation of Initial Draft

The researcher developed the 61 items for the initial draft. Items were examined the mindset of an individual to act in any situation, accept or reject anything, curiosity, scientifically and logically solve the problem and Creativity. Items were positive and negative both the weightage of both positive and negative statements was the same in a reverse manner. To prevent the impacts of central tendency, a five-point scale was created. Strongly Agree, Agree, Undecided, Disagree, and Strongly Disagree were the points. Tool's initial draft was submitted to supervisors, and five science teachers of Kamaran Model school and mailed to seven experts to evaluate the initial draft.

3.6.5.c Evaluation of Initial Draft

The supervisor and experts suggested the following modification and changes make it suitable for secondary school students and convenient for study.

-Use the appropriate grammatical statement.

-Split the long statements into two

-Unspecific statements, which could not measure the scientific attitude were excluded.

-Eliminate those statements which could not the level of secondary school students.

-Add some required statements.

-Some terms are identified to convert them into simple terminology.

To check the language error researcher, send a scientific attitude test to language experts in both English and Hindi. The researcher has corrected and modified the statements according to their suggestions. As per the objective of the study both private and government students in IXth class were the population. So, items were in both English and Hindi Languages. For understanding, the language and terminology of items investigator and supervisor conducted a meeting with 20 students in the Sixth class. Statements were read in front of students and instructed them to only understand the real meaning of statements and terminologies not respond to the statements. So, we confirm the statements which were easily understandable by students.

3.6.5.d Item Analysis

Reliability- It is used to determine the consistency of a test. To determine the consistency of the scientific attitude test, the researcher used the split-half method (Spearman Brown proficiency formula).

The reliability of the test is= 0.8358.

Validity- Validity is the extent to which a test captures the expected outcomes. it is about the accuracy of measurement and helps to evaluate the quality of research. There are different methods to find validity. But researcher applied content validity- Send the soft copy of the scientific attitude of 20 judges for validation out of them only 11 judges send their responses. The expert reviewed each tool item for content validity in the applied relevance category. It has 4 indicators of relevance.

1. Cutout the item would not affect the measurement of the dimension of scientific attitude.
2. Repeated ideas were avoided.
3. Discard that items were not suited to the age level of students.
4. Remold a few somewhat relevant statements.

Researcher pic only those items which are rated 4 by 60% of judges. In this way out of 61 only 40 items were selected.

3.6.5.e Preparation of the Final Draft

Suggestions and opinions of the experts and supervisor were applied in the final draft of the tool. The statements were made fair, concise, and specific, certain unclear or vague items were deleted. The remaining items were selected for a final draft. Statements were arranged from easy to difficult and mixed with negative statements. The instructions for answering the tool like time duration and weightage of statements were given. Some initial information about students like name, class, type of school, place of school, etc. were given along with the tool.

Table 3.7

Distribution of Views in the Scientific Attitude Scale

Positive Statements	**Negative Statements**
1, 2, 3, 4, 5, 12, 13, 14, 15, 16, 17, 18, 19, 20, 27, 29, 30, 31, 35 and 38	6, 7, 8, 9, 10, 11, 21, 22, 23, 24, 25, 26, 28, 32, 33, 34, 36, 37, 39 and 40

3.6.5.f Method of Scoring- On the rating scale, each response was scored by allocating points to statements that were considered positive. The points were allocated as follows

Strongly Agree-5

Agree-4

Undecided-3

Disagree- 2

Strongly Disagree-1

For items of negative polarity, the responses were scored as follows-

Strongly Agree-1

Agree-2

Undecided-3

Disagree-4

Strongly Disagree-5

The count score of all 40 statements provides the scientific attitude score of a student.

3.6.6 Norms of Scientific Attitude Scale

The researcher constructed a scientific attitude scale and set the norms. For this researcher calculated the z-score and those have greater than +1, the z-score was considered as the Above Average group, those who come under between the value of 0 to 1 had average level of scientific attitude and those have less than -1 value were taken as below the average level of scientific attitude.

Table- 3.8

Description of Norms of Scientific Attitude

	z-score	Level
Scientific Attitude	Less than -1	Below Average
	Between 0 to +1	Average
	Greater than +1	Above Average

3.6.7 Administration

The scientific attitude scale's final form was administered after being taught by flipped classroom and lecture method on treatment and controlled group respectively of both types (Private and Government) students. The pupils were given instructions to carefully read the instruction, fill out their data, and mark their responses.

3.7 Science Achievement Test

Achievement tests are helpful in remedial teaching programs and in deciding which class a student should be admitted to. By giving this test regularly, teachers can better understand the challenges that their students face in the classroom and find ways to make their instruction more effective. Achievement tests help determine how effective a lesson is and also highlight where a lesson's procedures need to be improved. A test is created to measure the level of understanding of a certain subject or skill. Achievement tests aim to know an individual's level of performance by measuring what and how they have learned. The teacher-made test is generally an achievement test.

3.7.1 Construction of Achievement Test

It is necessary to specify the test's objective and purposes before creating the achievement test. A flawed understanding of the goal of the accomplishment exam must exist. The degree of achievement exam must be decided upon after the purpose has been chosen. There should be a set curriculum for test makers. The test items may be created in such a way as to also serve as examples of subject-matter knowledge, comprehension, application, analysis, synthesis, and evaluation.

Not only for learner performance or benefit but also for the instructor to analyze both his or her work and teaching methods, classroom learning must be assessed or evaluated. The teacher should gather feedback on what the students have learnt as a result of the instructor's efforts after each lesson or group of lessons in order to identify the most successful teaching methods. This evaluation

includes an accomplishment exam. A unit's performance on an accomplishment test will be assessed as part of the teaching and learning process.

3.7.2 Purpose of Achievement Tests

- It is frequently used in classrooms for the reasons listed below.

- To ascertain whether the students have achieved the desired learning objective.

- Throughout the teaching-learning process, assist in guiding students' learning and provide ongoing feedback to both students and teachers.

-To determine the learning challenges of students.

-To assign grades.

- To identify the teaching methods which are best for students' learning (age, subject and content-wise).

- For achievement tests, a variety of question styles are employed, including essay, short-answer, and objective questions. The objective-type questions were chosen by the researcher because they are free of subject bias. Although objective questions can take many different forms, they often call for brief responses with little or no writing. It might only take an oral response or a simple tick.

1. Simple Recall
2. Multiple choice
3. True- False
4. Matching block

Multiple questions are used by the researcher to construct an achievement test. The researcher has put four options for each question which one is the correct

and best answer to the question. Multiple choice questions are mostly used it is best to determine the good or poor students.

3.7.3 Blue Print

The blueprint is an important step to construct an achievement test. It is a chart reporting the number and type of questions represented across the topics or chapters. It specifies the relative importance of the cognitive domains (Bloom's taxonomy) Knowledge, Understanding, Application, Analysis, Synthesis, and Evaluation domains. Learning objectives were categorized in accordance with Bloom's taxonomy of aims in the cognitive domain. Questions were scrutinized by a researcher for the correctness of the question's dimension or domain. The researcher mailed the blueprint copy of 10 experts to accurate the question's domain. After finding the responses of experts' the researcher corrects them ad forms a final draft of the achievement test.

3.7.4 For the development of the science achievement test, the following sources were consulted: (Biology)

1. Science textbook for Class Ixth NCERT
2. Foundation Science Biology for Class- 9 Bharti Bhawan
3. Science for Ninth Class Part-3 Biology (S. Chand School)
4. Saral jeev vigyan bhag-1 for Class IXth (Lucent's)
5. A Book of Biology with Practical Class IXth (Alok Bharti Prakashan)

3.7.5 Screening of Test Items

This test was described as representative of pupils in secondary schools. This was done to keep one of the synonymous things and those that would fit

into the competency framework. Vague items were removed, and the remaining items were clarified. The researcher studied the scientific technique and goals before creating the test items. Before 100 items were developed. 434 secondary school pupils took the test and received some teaching.

-Only research purposes would be served by using the test results.

The researcher's ability to determine the test's reliability would be aided by the students' accurate replies to test questions.

3.7.6 Item Analysis-

After scoring the item it is very needed to analyze the item. Item analysis is a statistical approach used to choose and reject test items based on their level of difficulty and ability to distinguish across groups.

Difficulty value- "The proportion or percentage of the examinees who have answered the items correctly is defined as the difficulty value of an item." J.P. Guilford

The formula of difficulty value (D.V)

D.V = (R.H+R. L) / (N.H+N. L)

Where R.H= rightly answered by highest group of testees

R. L= rightly answered by lower group of testees

N.H= no. of examinees in higher group

N. L= no. of examinees in the lower group

The following table displays the results of the analysis of the difficulty indices using the Henning (1987) guidelines:

Table 3.9

Henning's Guidelines (Difficulty Value)

High Difficult	**Medium**	**Low (easy)**
High (≤ 0.33)	0.34-0.66	≥0.67

Based on Henning's Guideline 100 test items categorized

Table 3.10

Distribution of difficulty value (D.V) of items

Level of difficulty	**Items**	**Total**
High (Difficult) (≤ 0.33)	Pretest- 5, 6, 10, 11, 13, 14, 17, 23, 27, 29, 30, 32, 34, 36, 38, 43	16+25 = 41
	Posttest-1, 3, 7, 11, 12, 16, 17, 18, 20, 21, 22, 24, 25, 27, 28, 32, 33, 34, 37, 39, 40, 43, 44, 46, 50	
Medium (0.34-0.66)	Pretest- 3, 4, 7, 11, 16, 17, 18, 20, 21, 22, 25, 27, 28, 32, 33, 34, 37, 39, 40, 41, 42, 44, 46, 47, 48, 49, 50	27+25 =52
	Posttest- 2, 4, 5, 6, 8, 9, 10, 13, 14, 15, 23, 24, 26, 29, 30, 31, 35, 36, 38, 41, 42, 45, 47, 48, 49	
Low (≥0.67) Easy	Pretest- 1, 2, 12, 15, 19, 45	6+1= 7
	Posttest- 19	
	Total	100

Discrimination power- how items are separated or discriminated against high scores and low scores of entire tests. The index of discrimination is another name for it. The ability of a thing on which superiors and inferiors are

differentiated is known as the "index of discrimination." Through Blood and Budd (1972). The range of the discriminative power is +1 to -1. It is of three types zero, positive and negative.

The discriminative index of each item is calculated by the following formulas-

$$Dp = (Nu – NL)/(N/2)$$

Where- Dp- discrimination power

Nu- number of higher group students answering the item correctly

NL- number of lower group students answering the item correctly

N- total no. of students

Ebel's guidelines were used in this analysis

Table 3.11

Ebel's Guidelines (1979) (Discrimination power)

Discrimination power	**Description**
0.40 and above	This item is quite satisfactory
Between 0.30- 0.39	Less or no revision is required
Between 0.20- 0.29	The item is marginal and need revision
≤ 0.19	The item should be eliminated or completely revised

Table 3.12

Based on Ebel's guidelines 100 items are categorized

Discriminating power	**Items**	**Frequency**	**Remarks**
0.40 and above	Pretest- 3, 4, 7, 8, 16, 21, 22, 26, 28, 31, 33, 37, 39, 40, 41, 42, 44, 45, 46, 48	20 + 19	Very good item
	Posttest- 2, 4, 5, 6, 10, 13, 14, 15, 19, 23, 24, 26, 29, 30, 36, 38, 41, 42 48	= 39	
Between 0.30- 0.39	Pretest- 2, 5, 15, 18, 19, 49, 50	7 + 3	Reasonably Good items
	Posttest- 8, 9, 31	10	
Between 0.20- 0.29	Pretest- 1, 6, 20, 24, 25, 32, 35, 47	8 + 9	Need Improvement
	Posttest- 11, 22, 33, 35, 39, 40, 45, 47, 49	17	
≤ 0.19	Pretest- 9, 10, 11, 12, 13, 14, 17, 23, 27, 29, 30, 34, 36, 38, 43	15 + 19	Very poor item
	Posttest- 1, 3, 7, 12, 16, 17, 18, 20, 21, 25, 27, 28, 32, 34, 37, 43, 44, 46, 50	= 34	
Total		**100**	

Table 3.13

Final draft

Level of difficulty→ **Discrimination index ↓**	**Moderate (0.34- 0.66)**	**Total**	**remarks**
0.40 and above	**Pretest-** 3, 4, 7, 8, 11, 16, 17, 18, 20, 21, 22, 25, 26, 28, 31, 32, 33, 34, 37, 39, 40, 41, 42, 44, 45, 46, 47, 48, 49, 50	30 + 26 =56	Very good items
	Posttest- 2, 4, 5, 6, 8, 9, 10, 13, 14, 15, 19, 23, 24, 26, 29, 30, 31, 35, 36, 38, 41, 42, 45, 47, 48,49		
Between 0.30- 0.39	**Pretest-** 2, 5, 15, 19	4	Reasonably good items
Total		60	

Table 3.14

Distribution of Marks to Different Instructional Objectives

Sl. No.	Instructional objectives	Marks	Percentage (%)
1	Knowledge	15	25
2	Understanding	14	23.3

3	Application	10	16.6
4	Analysis	7	11.6
5	Synthesis	7	11.6
6	Evaluation	7	11.6
	Total	**60**	**100%**

Table 3.15

Content Weightage

Sl. No.	Topics	Marks	Percentage
1	The fundamental unit of life: Cell	10	16.6
2	Tissue	14	23.3
3	Diversity in living organism	17	28.3
4	Why do we fall ill	19	31.6
	Total	60	100%

3.7.7 Scoring

It means to give the value of responses. In this test, the items have in the form of a multiple-choice question. Every correct response carries one (1) mark and zero (0) for every wrong answer. Total items' scores performed science achievement.

3.7.8 Norms of Science Achievement test

The researcher self-constructed the science achievement test and set the norms. For this researcher calculated the z-score and those have greater than +1,

z- score was considered as the Above Average group, those come under between the value of 0 to 1 had an average level of science achievement and those have less than -1 value were taken as below the average level of science achievement.

Table-3.16

Description of Norms of Science Achievement

Science Achievement	z-score	Level
	Less than -1	Below Average
	Between 0 to +1	Average
	Greater than +1	Above Average

3.7.9 Reliability

It is used to determine the consistency of a test. So, the researcher used the split half method (Spearman Brown proficiency formula) to find the consistency of science achievement tests. The calculated value of the reliability of the test is 0.997. Cronbach's alpha was also used to find the internal consistency reliability. The calculated value of Cronbach's α is 0.933.

3.7.10 Validity

The degree to which a test measures what it is intended to measure is referred to as validity. It is about the accuracy of measures and helps to evaluate the quality of research. Validity can be measured using a variety of methods, including face, content, construct, predictive, and concurrent validity. The researcher used content validity, a method that, in the opinion of experts, measures substance. The opinions of experts were taken into account. A test

was administered to determine the validity of the science achievement test 10 subject experts, 5 experts and a supervisor. Experts gave many suggestions and opinions. Considering all the opinions of experts' the researcher finalized the test items and, in this way, the validity of the test was established.

3.8 Conduction of Experimental Research and Data Collection

Since the study is experimental, data collection is time taking and it is very important to work in the research process. It was carried out in the following phases. For that firstly, we selected two schools conveniently one belongs to a private school (Salfia School) and the other government school (Zila School). The researcher only selected that school that has at least two sections of the IXth class.

3.8.1 Phase 1: School Visit

After the worldwide epidemic, COVID-19 lockdown schools were reopened in July 2021 and properly ran in August 2021. The researcher telephonically connected with the principals of schools and after many tryouts, they gave me a chance to experiment. The researcher visited the schools of Darbhanga city. The heads of the schools were informed of the study's objectives, and permission was secured to carry out the experiment.

3.8.2 Phase 2: Preparation of Experiment and Made the Repo with Students

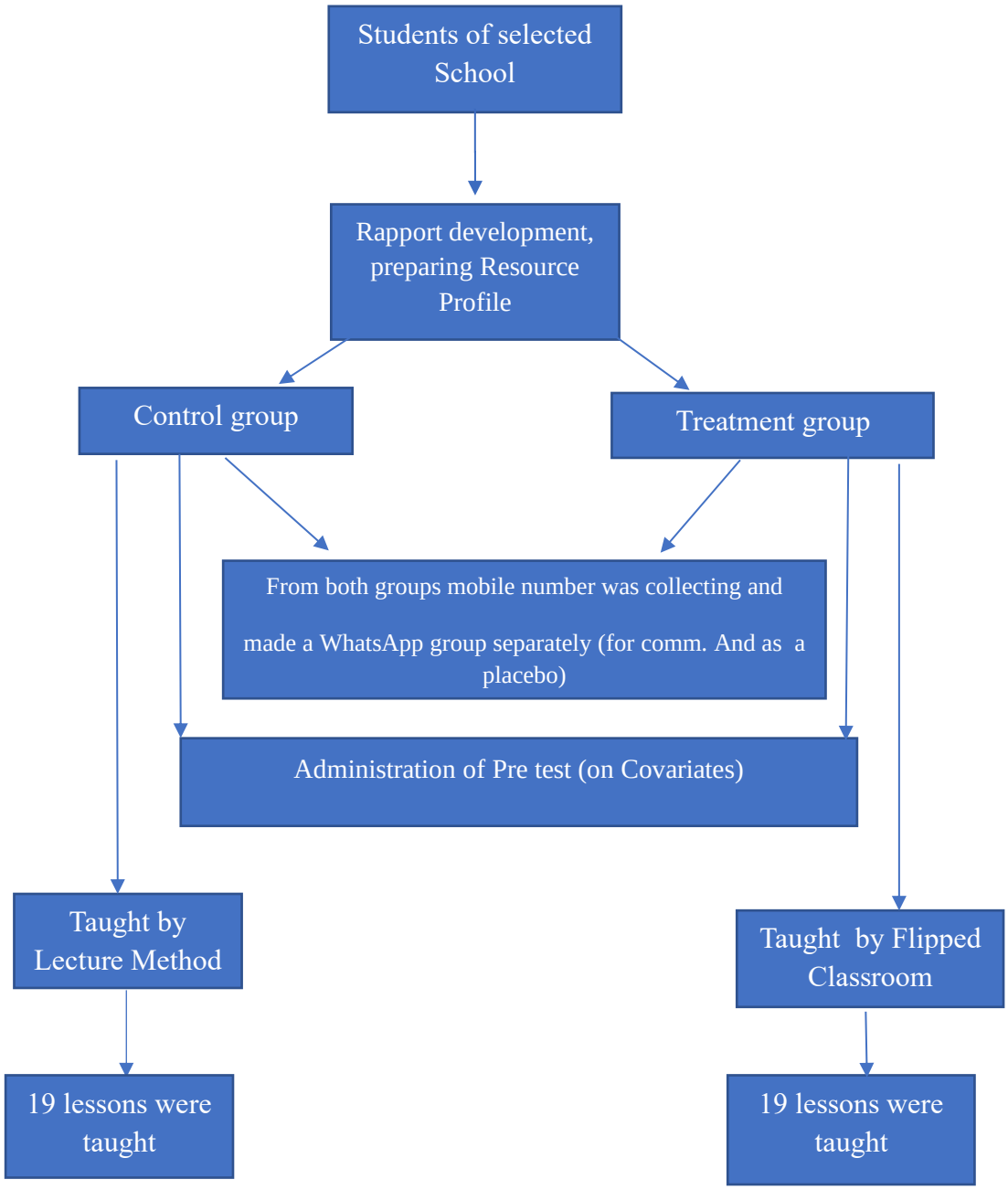
The researcher visited the schools and met the students and science teacher of the IXth class. Two sections were randomly selected (fish bowl method) for the treatment and control groups. All the students of Salfia school

(private school) had the devices/equipment which made it possible them for the flipped classroom. So, there was no need to conduct the demographic profile and then both the sections of Salfia school were randomly selected for treatment and control group. But all the students of Zila school (government school) had no devices which made it possible for the flipped classroom. So, there was a need to conduct the demographic profile. After getting that researcher separated the students who had such electronic devices/equipment which made it possible for them, for the flipped classroom to be selected for the experimental group. And those who had no such devices/equipment were selected for the control group.

3.8.3 Phase 3: Execution the Experiment

Figure 3.3

Flowchart of Excution of Experimental Research



3.8.4 Development of Flipped Classroom

The researcher has randomly finalized the chapters of IXth class science (biology) books common in both syllabus government and private. She studied different types of resource books like NCERT, SCERT, Bharti Bhawan, S. Chand publication, Lucent's biology, etc., and took references from google, YouTube, and different types of learning apps. She prepared learning material (text and video) for the flipped classroom and the lesson plan for the lecture method and checked it by a supervisor, Faculty of Education and subject experts. Their corrections, suggestions and opinions included flipped classroom planning and its lesson plan.

3.8.5 Validity and Reliability of Flipped Classroom

The researcher has developed a flipped classroom for improving the science performance of secondary-level students. Like- Science Achievement, scientific attitude, and creative thinking. Researcher conducted a pilot study to test the validity and reliability of flipped classrooms and learning material.

3.8.5. a Pilot Study

Before beginning a large research effort, pilot study results were very important. Before doing any extensive quantitative research, a pilot study was done, often known as a "feasibility study," is carried out to assess the viability of a future full-scale project. With the aid of this study, the researcher can identify any anomalies (strange things), confusion regarding the material provided to participants, or issues with the task generated. Pilot studies give

researchers access to early data that will help them understand the potential outcomes of their proposed experiment.

3.8.5.b Objectives of Pilot Study

- To evaluate the efficacy and dependability of the flipped classroom model and the learning materials it uses.

- The larger study's potential difficulties will be better handled by the researchers, and they will feel more comfortable using the data collection tools.

- The primary goal of the pilot study was to evaluate the strategy and methods of the major experimental study.

To examine the impact of the lecture technique and the flipped classroom on the performance of the pilot group's science pupils.

3.8.5.c Implementation of Pilot Study

The researcher implemented the pilot study on 50 students of IXth class of +2 High School Nahas Khangraitha. She randomly selected the sections for the experimental and control group. The boys' sections come under the experimental and the girls' sections were for the control group. All the students of sections were taken as sample which present complete duration of experiment hence 25 students were selected from experimental and 25 were taken as control group. According to the topic "A Comparative Study of Flipped classroom and Lecture method on Performance of Science Students at Secondary level" the researcher had to teach by both flipped classroom and lecture methods. For this, she prepared the lesson plan for both methods. For flipped classroom researcher prepared the learning material in the text and video forms of science subjects,

especially biology. For the pilot study researcher taught the one-chapter Fundamental unit of life: Cell from 19th August 2019 to 27th August 2019. The researcher had taken all the same procedures which she had taken in the main study. For flipped classroom researcher gave the learning material one day before, the next day researcher (teacher) cleared the doubt of students and gave the answers to questions, and second, the next day group discussion was held in class in science period. In the control group, the researcher also taught using the lecture technique. Following completion of the four lessons from the Fundamental Unit of Life: Cell researcher took the test of elective dependent variables (science achievement, scientific attitude, and creative thinking) on 29th August and collected the data. The details of flipped classroom and lecture method in the pilot group are given below.

Table- 3.17

Details of Fundamental Unit of Life: Cell, Lesson Plan of Lecture Method and Videos of Flipped Classroom

SI.No.	Chapter-1 Fundamental unit of life: Cell	Lecture Method	Flipped Classroom
	Topic of the chapter (title of the lesson plan of lecture method and learning material of flipped classroom's text and video	Lesson plan time duration in minutes	Time duration of video in minutes
1.	What is the living made up of?	45	16
2.	Structure of cell (plasma membrane and cell wall)	45	17

3.	Nucleus and Chromosome	45	14
4.	Cytoplasm and cell organelles	45	15

3.8.5 d Problems Occurred During Implementation of Flipped Classroom for Pilot Study.

The researcher attentively watches all the threats, Observed the student's behavior and asked them about the learning material which had been provided to students. Students said that-

- videos had some noise problems.
- Text was used in the video which is only in English so, students were unable to understand it.
- Time management was not appropriate in the lecture method's lesson plan was too long and took more time to complete it.
- In flipped classrooms sometime group discussions were taken more time to complete it.
- Some video clips were too long to bored the students and were not much more effective.

3.8.5.e Data Collection of Pilot Group

After implementing the flipped classroom and conducting the post-test on the pilot group. Then she collected the data and feed it into excel 2019 sheet. Then she analyzed the data in IBM SPSS (2017) by using ANCOVA to nullify the socioeconomic status and intelligence. The details of the statistical analysis of the study are given below.

3.8.5. f Statistical Analysis and its Interpretation

Table- 3.18

Descriptive Statistics of Dependent Variables

Dependent Variable	Methods of Teaching	Mean	S. D	N
Science Achievement	1	6.92	2.75	25
	2	7.36	2.78	25
Scientific Attitude	1	73.32	13.33	25
	2	76.24	10.94	25
Creative Thinking	1	83.16	44.33	25
	2	98.12	46.23	25

Table 3.19

Levene's Test of Homogeneity of Variance of Dependent Variables

Dependent Variables	F	df1	df2	P	Sig
Science Achievement	.688	1	48	.411	NS
Scientific Attitude	.866	1	48	.357	NS
Creative Thinking	.085	1	48	.773	NS

For the present data the p value of all the dependent variables in table 3.18 are greater than .05 hence the homogeneity of variance is fulfilled.

Table- 3.20

ANCOVA Table for effect of Flipped Classroom on Science Achievement

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Remark
Corrected Model	53.554[a]	3	17.851	2.595	.064	
Intercept	24.814	1	24.814	3.607	.064	
Intelligence Score	46.717	1	46.717	6.791	.012	S
SES Score	.548	1	.548	.080	.779	NS
Method of teaching	7.843	1	7.843	1.140	.291	**NS**
Error	316.466	46	6.880			
Total	2919.000	50				
Corrected Total	370.020	49				

a. R Squared = .145 (Adjusted R Squared = .089)

Table- 3.21

ANCOVA Table for effect of Flipped Classroom on Scientific Attitude

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	remark
Corrected Model	648.957[a]	3	216.319	1.509	.225	
Intercept	6275.372	1	6275.37	43.766	.000	
Intelligence Score	115.925	1	115.925	.809	.373	NS
SES Score	330.466	1	330.466	2.305	.136	NS
Method of teaching	100.811	1	100.811	.703	.406	**NS**

Error	6595.623	46	143.383			
Total	286847.000	50				
Corrected Total	7244.580	49				

a. R Squared = .090 (Adjusted R Squared = .030)

Table- 3.22

ANCOVA Table for effect of Flipped Classroom on Creative Thinking

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	remark
Corrected Model	4299.279[a]	3	1433.093	.680	.569	
Intercept	7340.580	1	7340.580	3.482	.068	
Intelligence Score	280.132	1	280.132	.133	.717	NS
SES Score	964.430	1	964.430	.457	.502	NS
Method of teaching	2594.032	1	2594.032	1.230	.273	NS
Error	96982.241	46	2108.310			
Total	512062.000	50				
Corrected Total	101281.520	49				

a. R Squared = .042 (Adjusted R Squared = -.020)

The F-test shown in the table 3.20, 3.21 and 3.22 of ANCOVA is computed based on the dependent variable (science achievement, scientific attitude and creative thinking). The type of teaching methods with two levels, flipped classroom and lecture method, are the independent variables. The dependent

variable is the student's science achievement, scientific attitude and creative thinking scores, and covariates are the socio-economic status and intelligence.

The analysis of covariance of science performance (science achievement, scientific attitude, and creative thinking) is not significant, F (y, x) (1,46) = 1.14, p=0.291>.05 (see table 3.20), F (y, x) (1, 46) = .703, p= .406>.05 (see table 3.21) and F (y, x) (1, 46) 1.23, p= .273 (see table 3.22) the finding shows that there is no significant difference between students, who were taught by flipped classroom (M= 7.3), (M= 76.24) and (M= 98.12) and students who were taught by lecture method (M= 6.92), (M= 73.32) and (M= 83.16) See table 3.18 having controlled for the effect of their socio- economic status and intelligence (covariates). Thus, the null hypothesis, "There is no significant difference between the science performance of the pilot group students who were taught through the flipped classroom and that of students who were taught through the lecture method," has not been rejected. This suggests that both the flipped classroom and the lecture technique were found to be equally successful in terms of student achievement in science, scientific attitude, and creative thinking. When their socio-economic status and intelligence were taken as covariates.

3.8.5.g Conclusion

After interpretation, the researcher reached the conclusion that flipped classroom doesn't significantly affect science performance (science achievement, scientific attitude and creative thinking) of pilot group students. The researcher expected that all the difficulties that occur during the

implementation of the flipped classroom in the pilot group will be removed then perhaps flipped classroom significantly effect on main study students.

3.8.5.h Correction of Pilot Study

After conducting the pilot study noticed all the possibilities which made the experimental study the best way. Found all the threats which is intentionally or non-intentionally occurred in the teaching process.

-Video had a voice problem, so the researcher removed the noise from the voice and increase the voice intensity of the video.

- Researcher edited the video text and used Hindi terminology and sentences.

- Researcher shortened the lesson plan of the lecture method and try to complete it in time duration.

- In flipped classroom require more time for group discussion. So, the researcher arranged the seating arrangement of students one day before for the next day's group discussion. The researcher gave a fixed time for each group. In this way, the researcher maintained the time and complete it on time.

- Long videos were shortened and reduced the video size to make them very effective.

- In this way researcher found the solutions to all problems that occurred during the implementation of the pilot study and is ready to implement the flipped classroom for the main study in the best way.

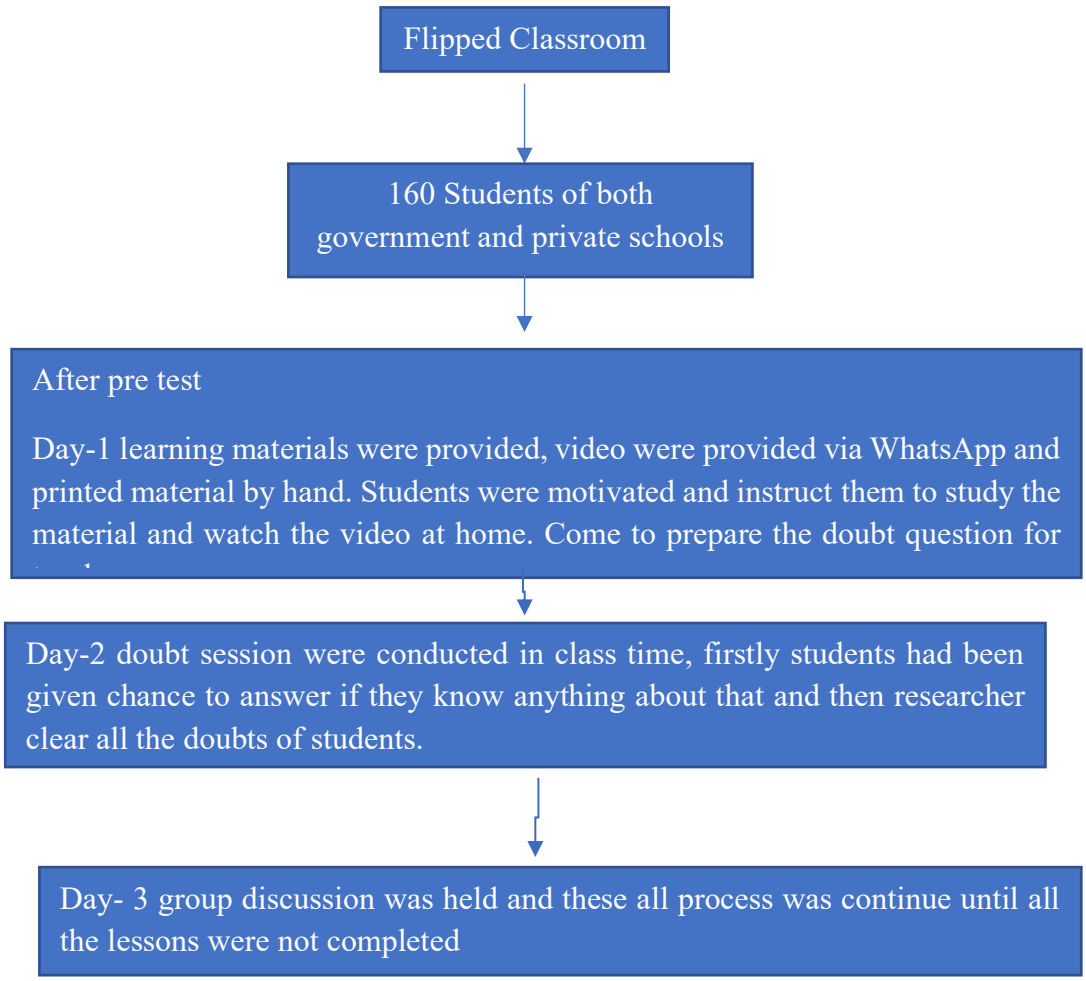
3.9 Implementation of Flipped Classroom for Main Study

The researcher conducted the experimental study on 160 students of both governments (B.K.D zila high school) and private (Salfia school) from

Darbhanga town. Researcher implemented the (Experiment) flipped classroom parallelly in both schools (government and private). This experiment was continued ran from August 2021 to October 2021 and check the effectiveness of 'Flipped Classroom' on science performance (science achievement, scientific attitude and creative thinking) at secondary level students. Details of the flipped classroom are given below.

Figure 3.4

Flowchart of Flipped Classroom



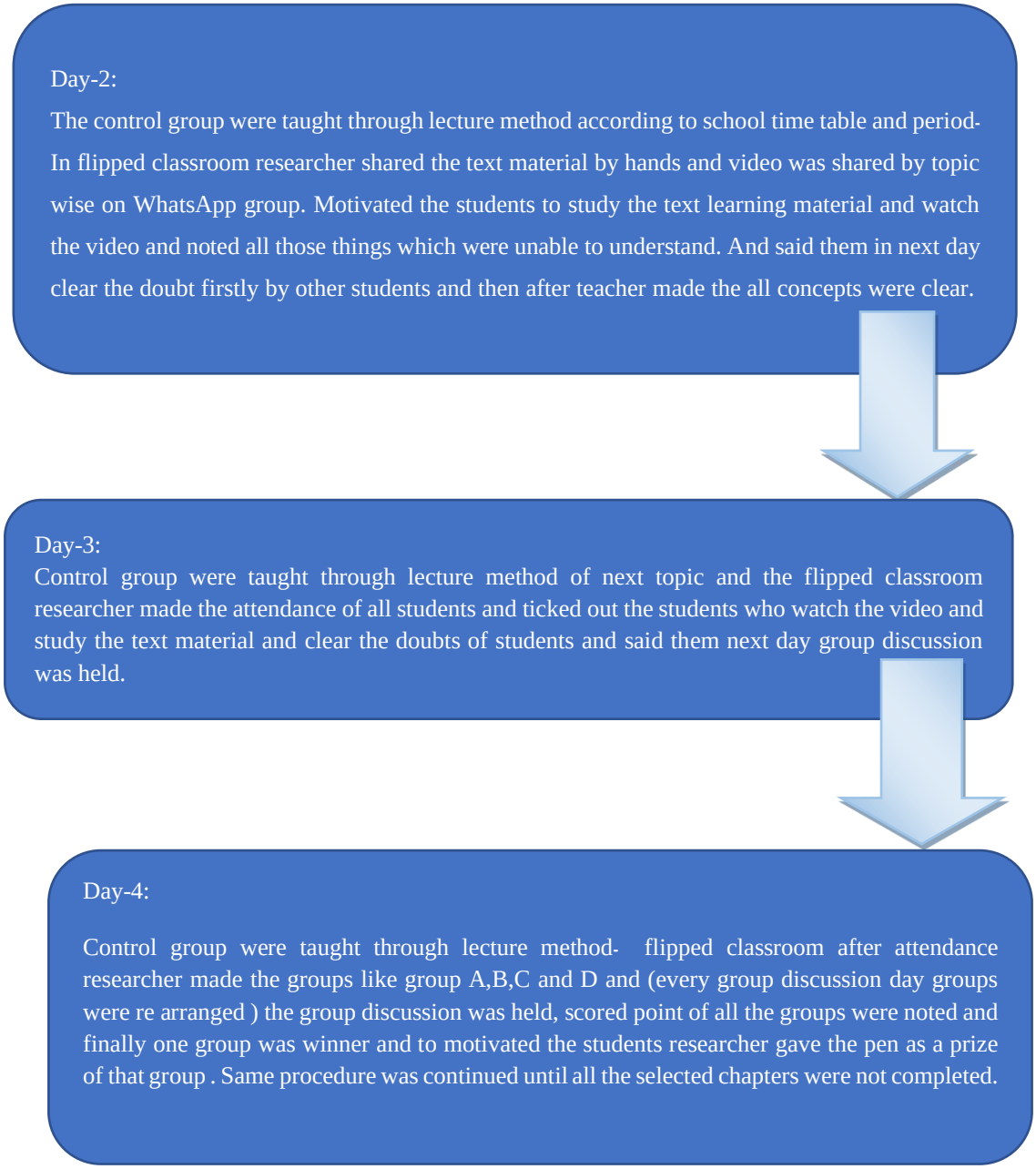
Day 1- Covariate variables (intelligence level and socioeconomic status) tests were given to both the experimental and control groups before the start of the treatment. Collect the phone numbers of all students and made WhatsApp groups separately for the control and experiment groups. The topics were selected from the IXth class syllabus of Biological Science which was common in both private and government schools.

3.9.1 Stage 1 Fundamental Unit of Life: Cell

Science (Biology) was taught to the control group using the lecture approach, while biology lessons were presented to the experimental group using the flipped classroom method.

Figure 3.5

Stage 1 Fundamental Unit of Life: Cell



to be asked during class discussions. The next day in the classroom students had given chance to ask their doubts. And firstly, other students have given to chance to tell anything which they know about it. After that teacher (researcher)

cleared all the doubts. And second, the next day group discussion was held during class time. In a group discussion, students were arranged sometime even odd roll number wise, sometimes serial wise roll number, and sometimes their seating arrangement. 5-6 students were in a group discussion. The researcher arranged the groups (like Group A, B, C and D) and put one question for one group and gave them 3 minutes to respond and put this same question to all groups. The researcher noted own their correct responses and marks them accordingly. Similarly, the next question was put to the next group and the same process was continued until each group's turn has not come. The process of the flipped classroom from sharing to learning material to group discussion was continued until all the selected chapters were not taught and, in another hand, parallelly lecture method was used to instruct the control group. After the course of treatment was complete, the researcher tested the dependent variables (Scientific Attitude, Science Achievement, and creativity test). Collect the scores, arrange the scores, coding the raw data after that data was analyzed and interpreted according to the objectives and hypotheses of the research.

Table 3.23

Details of Fundamental Unit of Life: Cell, Lesson Plan of Lecture Method and Videos of Flipped Classroom

SI.No.	Chapter-1 Fundamental unit of life: Cell	Lecture Method	Flipped Classroom

	Topic of the chapter (title of the lesson plan of lecture method and learning material of flipped classroom's text and video	Lesson plan time duration in minutes	Time duration of video in minutes
1.	What is the living made up of?	45	16
2.	Structure of cell (plasma membrane and cell wall)	45	17
3.	Nucleus and Chromosome	45	14
4.	Cytoplasm and cell organelles	45	15

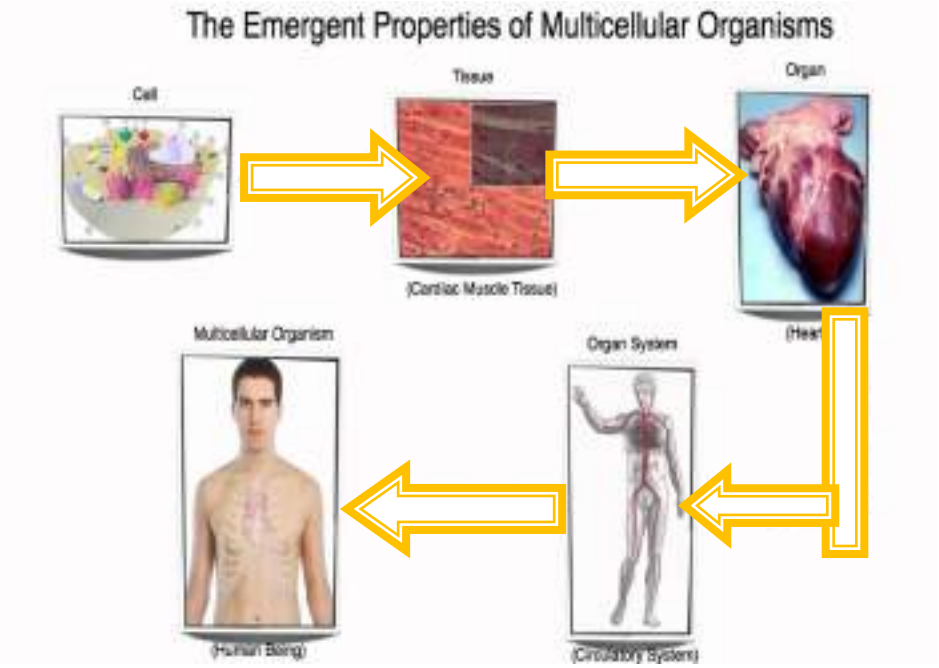
3.9.2 Description of Videos

Video-1 What is the Living Made Up of?

This video begins with the importance of cell in making our body. Cell is the structural and functional unit of life and building block of a living organism. The Discovery of cell and cell theory was explained. Unicellular and multicellular organisms, eukaryotes and prokaryotes had been described. The video attempts to understand the viewers about cell shape, cell size, cell number and cell volume.

Figure 3.6

What is the Living Made Up of?



https://youtu.be/JFpodr98CTM

The videos could be viewed as many times as the participants desired. They come to prepare questions and doubts for asking the teacher in classroom doubt clear session. All the queries and questions were satisfactorily cleared.

Day-2 Concept Exploration

After a one-day break, conceptual exploration started in the face-to-face form in the classroom on the second day. The participants in the conversation were asked the following questions.

Q.1- Why are cells considered the structural and functional building blocks of life?

Q.2- Who discovered cell and how?

Q.3- Why do different types of cells have different divisions of labor?

Q.4- Is it necessary, that different cells have different shape explain?

Q.5- Different organisms have a different number of cells why?

Q.6- How do eukaryotic and prokaryotic cells vary from one another?

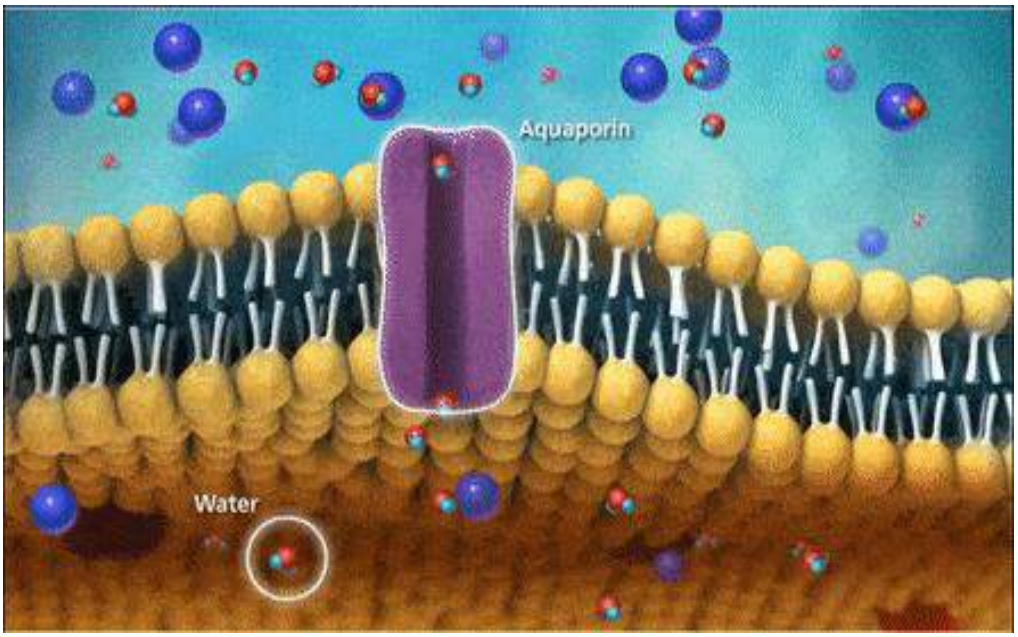
All the students were divided into a group like groups A, B, C, D & E number of groups depends on the presence of students in class. One question was posed to group A and gave them 3 minutes to respond and put this same question to all groups. The researcher noted their correct responses and marks them accordingly. Similarly, the next question was put to the next group and the same process was continued until each group's turn had not come. After completion of the group discussed their marks were added announcing the name of the winner group and giving them a prize for motivating all students. Similarly, the next topic of the fundamental unit of life: cell, learning material text, and video were shared. Same way doubt and question-asking session and group discussion was held like the first topic of cell was completed.

Video-2 Structure of Cell (Plasma Membrane and Cell Wall)

The second video of cell defines the structure of plasma membrane and its properties of transport. Explained the structure of cell wall and its function.

Figure 3.7

Transportation Properties of Plasma Membrane



https://youtu.be/-VosWJQiWGk

Participants watched the videos as many times as they wanted. They come to prepared questions and doubts for asking the teacher in classroom doubt clear session

Day-2 Concept Exploration

On the second day after a gap of 1-day, conceptual exploration began in the classroom in face-to-face mode. The following questions were posed to the participants as a group discussion question. The Group discussion was same as earlier.

Q.1- How do chemicals like water and carbon dioxide enter and exit cells?

Q.2- Why is a selective permeable membrane referred to as a plasma membrane?

Q.3- Why does the skin on your fingers shrink after a prolonged washcloth?

Q.4- Why is the transport of materials essential in living organisms?

Q.5- Why ATP is required for active transport?

Q.6- differentiate endocytosis and phagocytosis.

Video-3 Nucleus and Chromosome

In this video, the researcher explained the structure and functions of nucleus and chromosome. The type of chromosome according to the location of centromere and the number of chromosomes were shown and described.

Figure 3.8

Showed that Structure of Nucleus and Types of Chromosomes

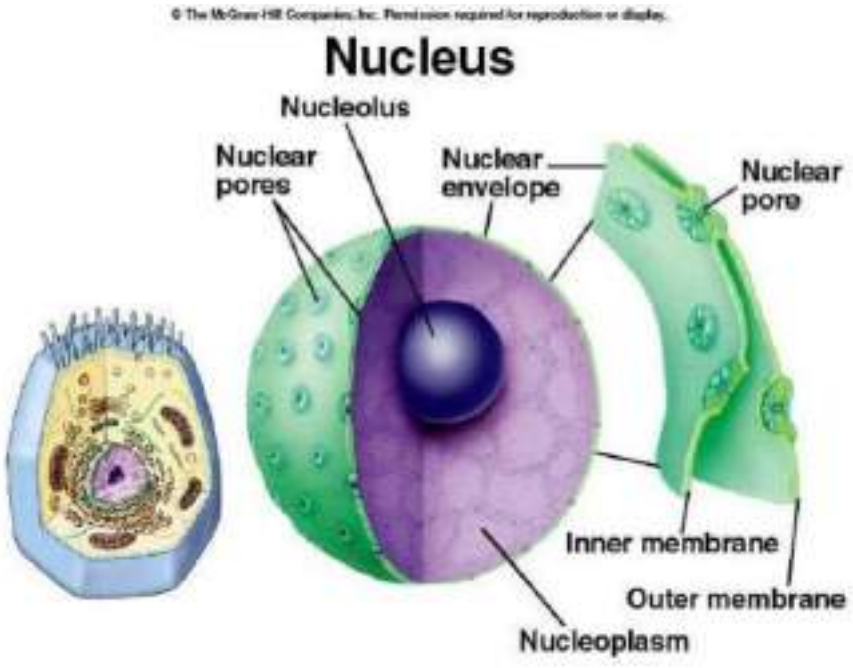
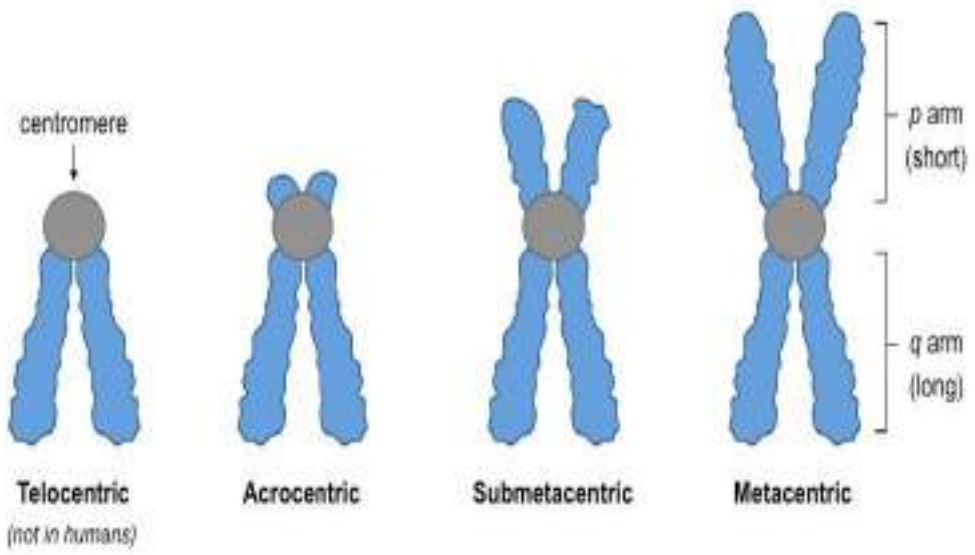


Fig-3.9

Types of Chromosomes According to Location of Centromere



https://youtu.be/nWrepd1gmz)

Participants watched the videos as many times as they wanted. They come to prepared questions and doubts for asking the teacher in classroom doubt clear session

Day-2 Concept Exploration

On the second day after a gap of 1-day, conceptual exploration began in the classroom in face-to-face mode. The following questions were posed to the participants as a group discussion question. The Group discussion was same as earlier.

Q.1- Why nucleus is necessary for cell?

Q.2- what is the function of chromosome?

Q.3- Why characteristics of parents and offspring are similar?

Q.4- How chromatid and chromosome related to each other?

Q.5- How haploid number of chromosomes is different from a diploid number of chromosomes?

Q.6- Why does the vacuole in plant cells have big size?

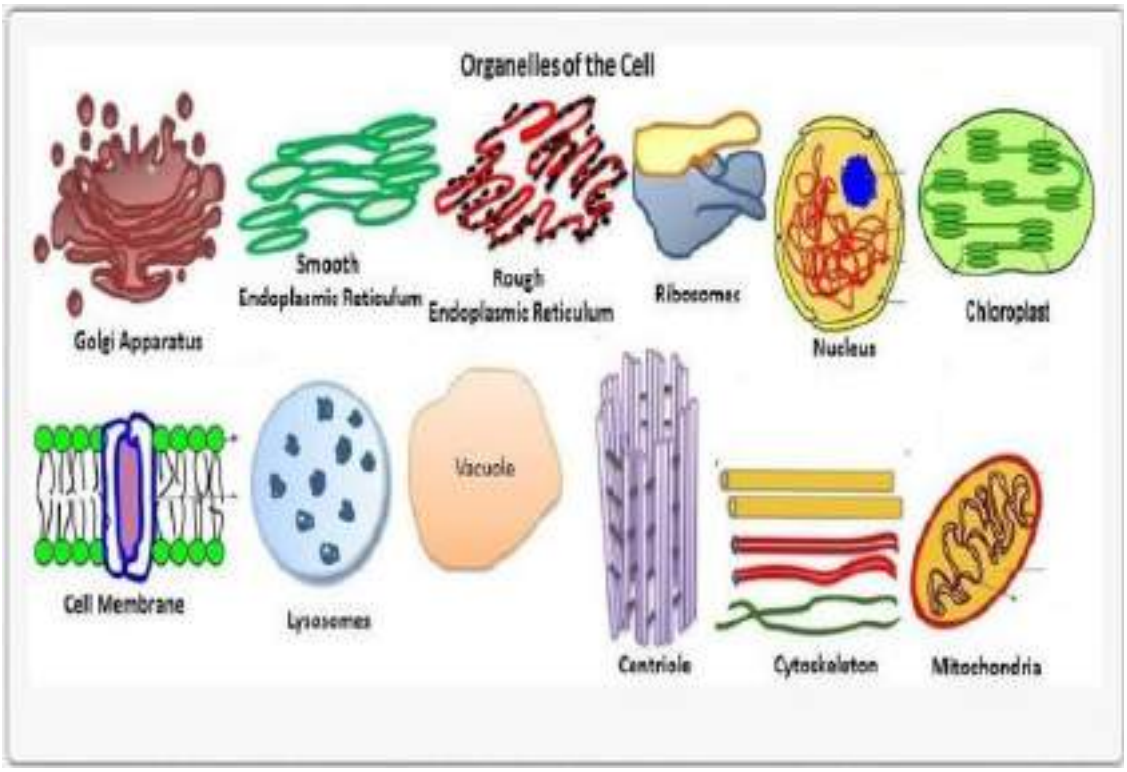
Q.7- describe the different types of chromosomes.

Video-4 Cytoplasm and Cell Organelles

This video began with the introduction of cytoplasm and its characteristics. The researcher explained cell organelles like endoplasmic reticulum, ribosome, Golgi apparatus, lysosome, mitochondria, plastid etc.) structure and function.

Figure 3.10

Cell Organelles



https://youtu.be/SaBl37PqwjM

prepared questions and doubts for asking the teacher in the classroom doubt clear session

Day-2 Concept Exploration

On the second day after a gap of 1-day, conceptual exploration began in the classroom in face-to-face mode. The following questions were posed to the participants as a group discussion question. The Group discussion was the same as earlier.

Q.1- Which organelle is referred to be the power house of the cell? Why?

Q.2- Why lysosomes are known as "suicide bags"?

Q.3- Differentiate rough and smooth endoplasmic reticulum. What role does the endoplasmic reticulum play in membrane biosynthesis?

Q.4- What would happen to a cell's life if the Golgi apparatus were to disappear?

3.9.3 Stage-2: Tissue

Participants were instructed to watch the following videos which were shared on your WhatsApp group

Table 3.24

Details of Tissues Lesson Plan of Lecture Method and Videos of Flipped Classroom

SI.No.	Chapter-2 Tissues	Lecture Method	Flipped Classroom
	Topic of the chapter (title of the lesson plan of lecture method and learning material of flipped classroom's text and video)	Lesson plan time duration in minutes	Time duration of video in minutes

1.	Meristematic Tissue	45	18
2.	Permanent Tissue	45	20
3.	Animal Tissues (Epithelial tissue)	45	15
4.	Animal Tissues (Muscular and Nervous tissue)	45	18
1.	Animal Tissues (Connective tissue)	45	20

Video-1 Meristematic Tissue

The video starts with an introduction to tissue, differences between plant and animal tissue classification of plant tissue have explained in the video. A Detail explanation of the types of meristematic tissue and their position in the plant.

Figure 3.12

Meristematic Tissue

https://youtu.be/ORDcYvUPPHU

prepared questions and doubts for asking teacher in the classroom doubt clear session

Day-2 Concept Exploration

On the second day after a gap of 1-day, conceptual exploration began in the classroom in face-to-face mode. The following questions were posed to the participants as a group discussion question. The Group discussion was the same as earlier.

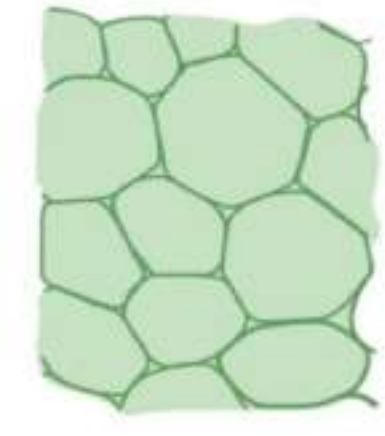
1. What is tissue? And what is the importance of tissue in a multicellular organism?
2. What is the difference between plant tissue and animal tissue?
3. Why did we need to classify the plant tissue?
4. Why meristematic tissue called parent tissue?
5. Define the types of meristematic tissue and explain the position.

Video 2- Permanent Tissue

Video began with the formation of permanent tissue and the types of permanent tissue. The detailed explanation of types of Simple and complex permanent tissue according to their function and location in plants.

Figure 3.13

Simple and Permanent Complex Tissue



https://youtu.be/Y3bLcnobK4s

Participants watched the videos as many times as they wanted. They come to prepared questions and doubts for asking to the teacher in classroom doubt clear session

Day-2 Concept Exploration

On the second day after a gap of 1-day, conceptual exploration began in the classroom in face-to-face mode. The following questions were posed to the participants as a group discussion question. The Group discussion was the same as earlier.

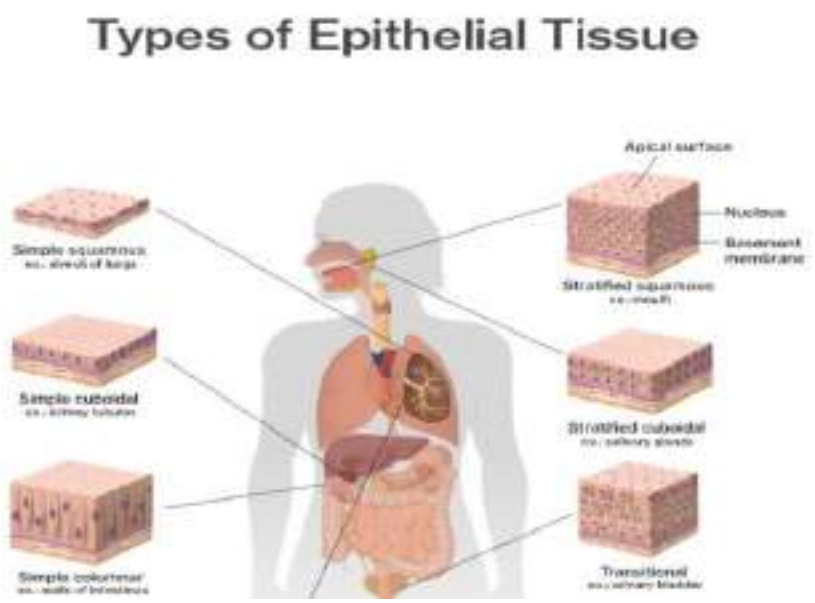
1. Differentiate the meristematic and Permanent tissue.
2. Define the type of simple permanent tissue and its function.
3. Differentiate sclerenchyma fibers and sclerieds.
4. What do you mean by protective tissue? Which type of tissues are included in it and what is its function?
5. Differentiate xylem and phloem.

Video 3- Animal Tissues (Epithelial tissue)

This video starts with animal tissue and its types. Explained the epithelial tissue and its type's structure, occurrence, and function

Figure 3.14

Epithelial Tissue



https://youtu.be/Y8MRiY4EH1Y

Participants watched the videos as many times as they wanted. They come to prepared questions and doubts for asking teacher in classroom doubt clear session

Day-2 Concept Exploration

On the second day after a gap of 1-day, conceptual exploration began in the classroom in face-to-face mode. The following questions were posed to the participants as a group discussion question. The Group discussion was the same as earlier.

1. Why we need to classify the animal tissue and what is the function of tissue?

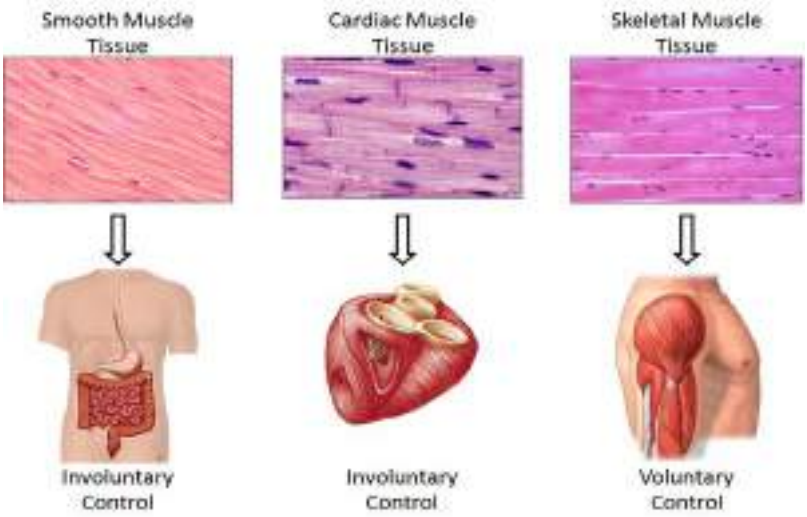
2. Describe the type of tissue and what do you mean by epithelial tissue and its function?
3. Explain the type of epithelial tissue with its figure.
4. Where squamous epithelial tissue is found and what is its function?
5. Differentiate the columnar and ciliated tissue?

Video- 4 Animal Tissue (Muscular and Nervous tissue)

Video start to revise the previous video and explained the muscular and nervous tissue. Defined the types of tissue and its function. Brief the nervous tissue and neurons.

Figure 3.15

Types of Muscular Tissue



https://youtu.be/QATWHA6wqC8

Participants watched the videos as many times as they wanted. They come to prepared questions and doubts for asking teacher in classroom doubt clear session.

Day-2: Concept Exploration

On the second day after a gap of 1-day, conceptual exploration began in the classroom in face-to-face mode. The following questions were posed to the participants as a group discussion question. The Group discussion was the same as earlier.

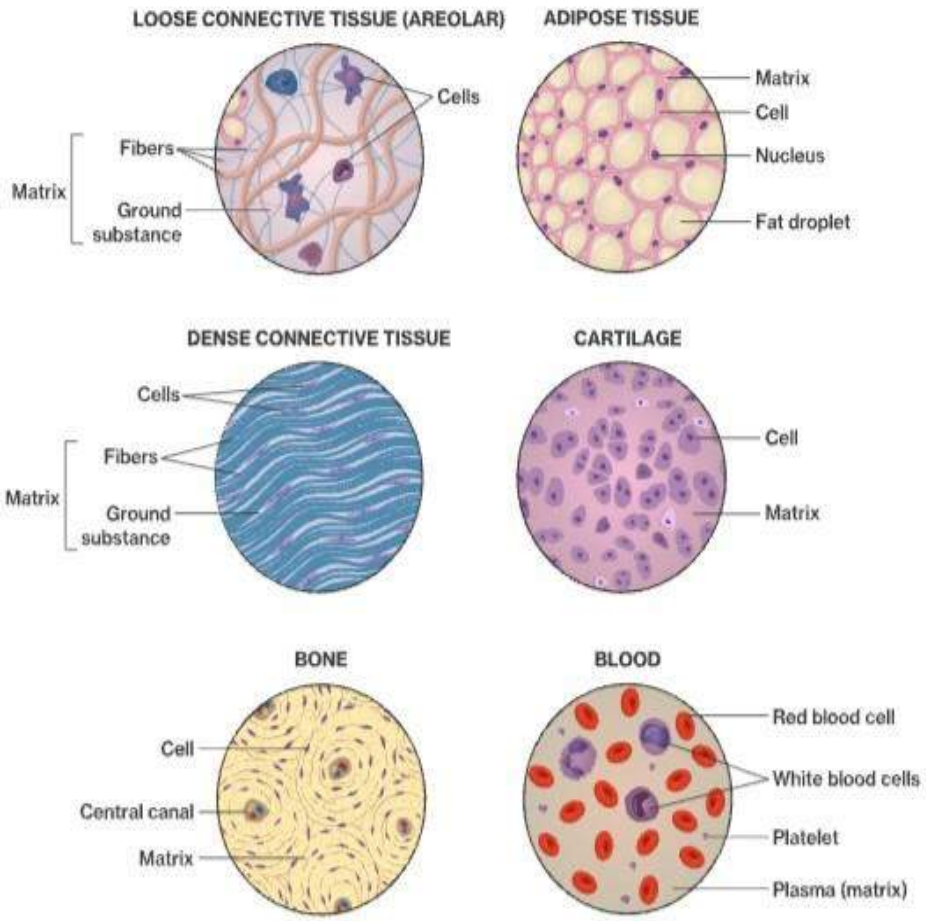
1. Explain the different types of muscular tissue and their occurrence.
2. Define the function of smooth muscle.
3. What is the function of cardiac muscle explain?
4. Compare the smooth, skeletal and cardiac muscle.
5. Explain the parts of the neuron and their function.
6. Differentiate the axon and dendrite?

Video-5: Animal Tissues (Connective tissue)

The video starts with the introduction of connective tissue and its types. A thorough explanation of types of connective tissue and skeletal tissue**.**

Figure 3.16

Types of Connective Tissue



https://youtu.be/UsE4o5XPX4c

Participants watched the videos as many times as they wanted. They come to prepare questions and doubts for asking teacher in classroom sessions. In the next day who did not come to watch the video for any reason they have a chance to watch the video on same day when discussion was held.

Day-2: Concept Exploration

On the second day after a gap of 1-day, conceptual exploration began in the classroom in face-to-face mode. The following questions were posed to the participants as a group discussion question.

1. What are connective tissue and its function?

2. Which cells are included in connective tissue?
3. Types of connective tissue, explain its occurrence.
4. Differentiate bone and cartilage and explain the function of bone.
5. What is fluid connective tissue? Explain its function.
6. Differentiate RBCs and WBCs.

Similarly, the next chapter Diversity in the living organism was prepared and participants were instructed to watch the following videos which were day by day shared on their WhatsApp group.

3.9.4 stage-3 Diversity in Living Organism

Table 3.25

Details of Diversity in Living Organism Lesson Plan of Lecture Method and Videos of Flipped Classroom

SI.No.	Chapter-3 Diversity in living organism	Lecture Method	Flipped Classroom
	Topic of the chapter (title of the lesson plan of lecture method and learning material of flipped classroom's text and video	Lesson plan time duration in minutes	Time duration of video in minutes
1.	Classification of living organism	45	10
2.	Characteristics of Kingdom Monera, Protista and Fungi	45	15
3.	Detailed classification of kingdom plantae	45	17
4.	Kingdom Animalia	45	18
5.	Kingdom Animalia (phylum Nematoda to Hemichordata)	45	13

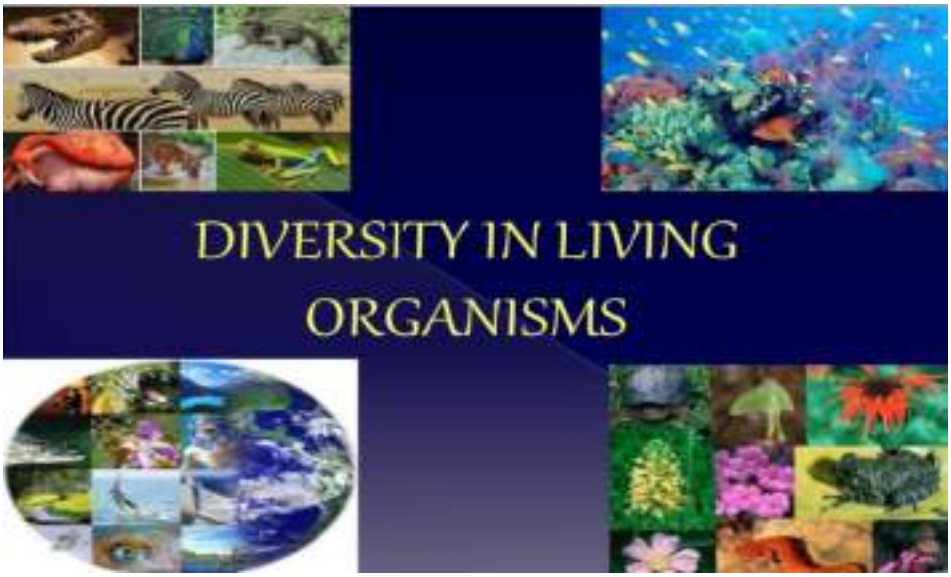
2.	Kingdom Animalia (detailed classification of phylum Chordata)	45	16

Video-1 Classification of Living Organism

The video began with the introduction of different types of living organism according to their shape size, living habits, mode of nutrition etc. A detailed explanation of the need for classification, the basis of classification, evolution and the hierarchy of categories or groups.

Figure 3.17

Diversity in Living Organism



https://youtu.be/_C25-b2TqVM

Participants watched the videos as many times as they wanted. They come to prepared questions and doubts for asking the teacher in classroom sessions -

Day 2: Concept Exploration

On the second day after a gap of 1-day, conceptual exploration began in the classroom in face-to-face mode. The following questions were posed to the participants as a group discussion question.

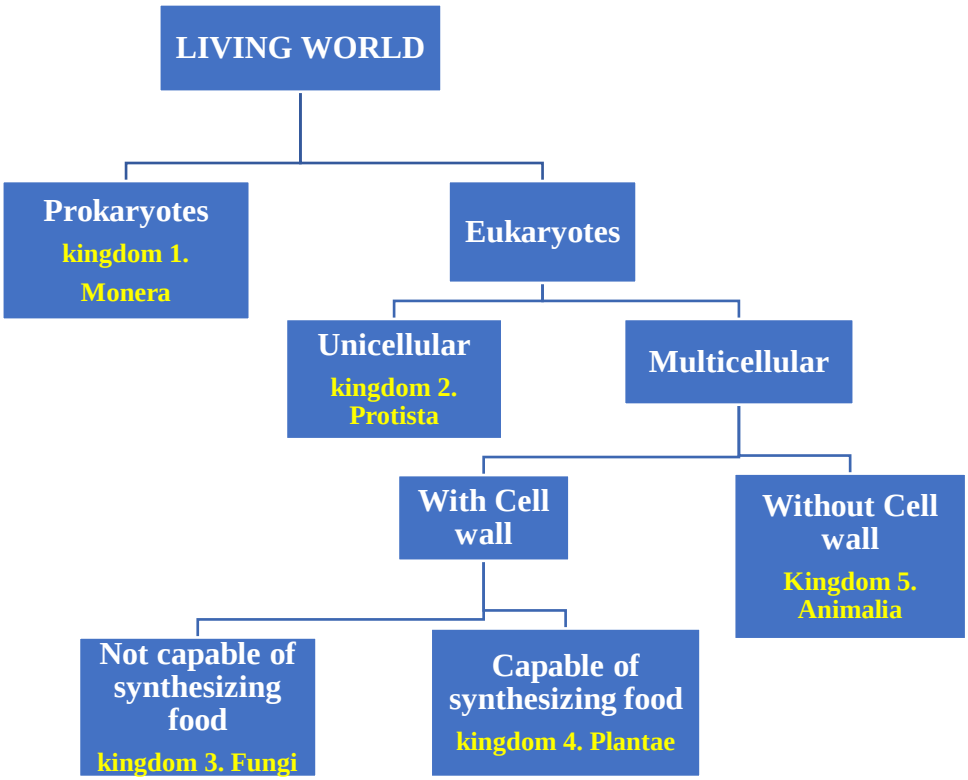
1. Why do we need to study diversity in living organism?
2. Why do we need to classify the organism?
3. What is the basis of classification?
4. How ancestor organism (simple organism) became a new or more complex organism?
5. If the categories or groups are not in hierarchy then which type of problem have to face to study the living organism?

Video-2 Characteristics of Kingdom Monera, Protista and Fungi

This video started with the revision of the previous video. In this video, the researcher showed and define the classification of living world. A very detailed explanation of kingdom Monera, Protista and Fungi.

Figure 3.18

Classification of Living Organism



https://youtu.be/nbOGLDZvZrs

Participants watched the videos as many times as they wanted. They come to prepared questions and doubts for asking to the teacher in classroom session

Day-2 Concept Exploration

On the second day after a gap of 1-day, conceptual exploration began in the classroom in face-to-face mode. The following questions were posed to the participants as a group discussion question.

1. Who divided the living world into five kingdoms, explain kingdom Fungi?
2. Explain the characteristics of the five kingdoms?
3. Are bacteria good or bad, give some examples and benefits of good bacteria.

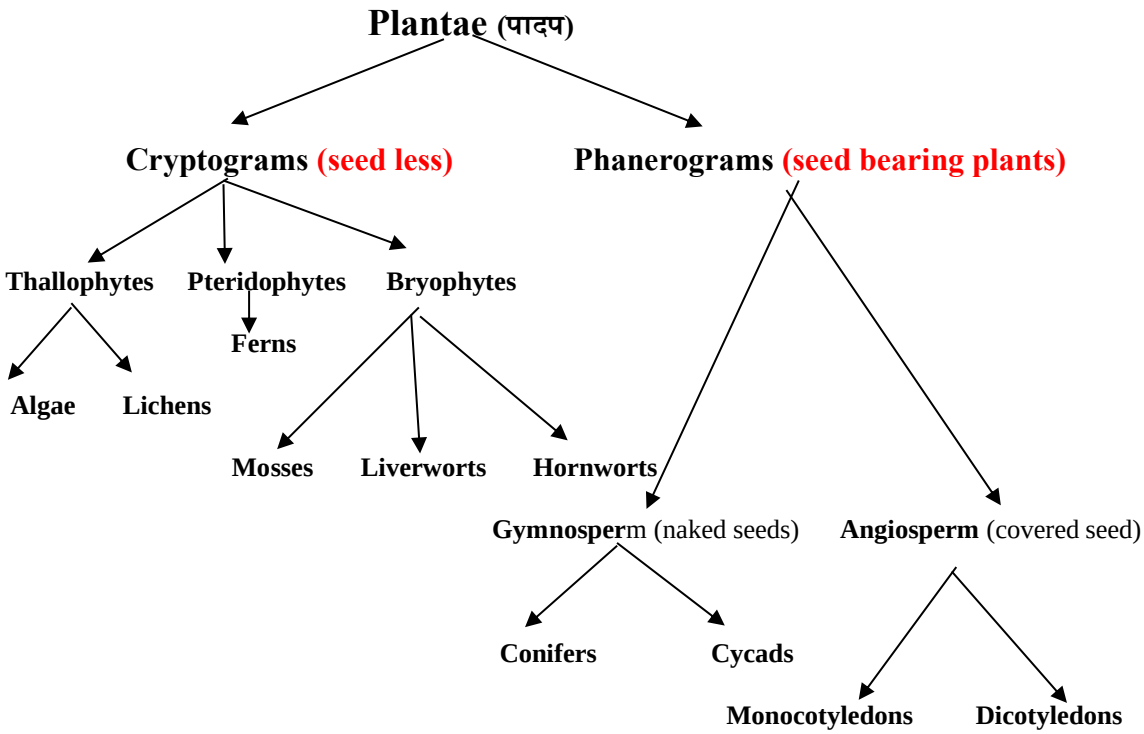
4. Why bacteria are put under the kingdom Monera explains it.
5. Give some examples of bad bacteria and how it affects human life explain.
6. Why Protista are grouped on the basis of nutrition, which type of nutrition are found in them?

Video-3 Detailed Classification of Kingdom Plantae

This video started with the revision of the previous video. The researcher explained the characteristics of the kingdom Plantae and their classification. This video has a very detailed description of each category of classification of kingdom Plantae, its characteristics with examples and sub-divisions of categories.

Figure 3.19

Classification of Kingdom Plantae



https://youtu.be/x7oUiMzIVoIVOY

Participants watched the videos as many times as they wanted. They come to prepared questions and doubts for asking teacher in classroom session

Day-2 Concept Exploration

On the second day after a gap of 1-day, conceptual exploration began in the classroom in face-to-face mode. The following questions were posed to the participants as a group discussion question.

1. Why we need to classify the kingdom plantae, explain their classification.
2. How Cryptograms are differed from Phanerograms give example.
3. Why Algae and fungi are in symbiotic association explain?
4. Differentiate Gymnosperm and Angiosperm with example?
5. Describe the difference between dicotyledons and monocotyledons in figure.

Video-4 Kingdom Animalia

This video started with the introduction of kingdom animalia and its characteristics. Researcher explained the bases of classification and its importance. In this video a very detailed description of kingdom Porifera, Coelentrata, Ctenophora and Platyhelminthes its characteristics with example

Figure 3.20

Animal Kingdom

https://youtu.be/gc9Or_EM_ml

Participants watched the videos as many times as they wanted. They come to prepared questions and doubts for asking to the teacher in classroom session

Day-2 Concept Exploration

On the second day after a gap of 1-day, conceptual exploration began in the classroom in face-to-face mode. The following questions were posed to the participants as a group discussion question.

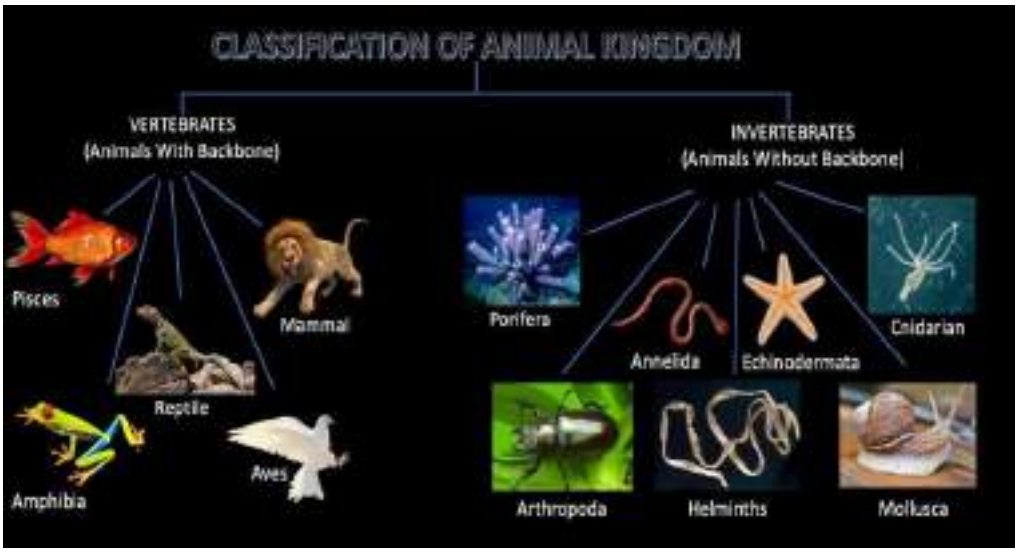
1. Define the characteristics of kingdom animalia?
2. Explain the classification of kingdom animalia?
3. Differentiate the bilateral and radial symmetry, in which symmetry do you belong?
4. In which phylum Planaria belong to, explain the characteristics of that phylum?
5. What do you mean by asexual reproduction and hermaphrodite organisms give examples?

Video-5 Kingdom Animalia (Phylum Nematoda to Hemichordata)

This video began with the revision of the previous video. This video explained the classification of the animal kingdom and Phylum Nematoda, Annelida, Arthropoda, Mollusca, Echinodermata and Hemichordata characteristics with examples.

Figure 3.21

Classification of Animal Kingdom



https://youtu.be/x_qal9FywGA

Participants watched the videos as many times as they wanted. They come to prepared questions and doubts for asking teacher in classroom session

Day-2 Concept Exploration

On the second day after a gap of 1-day, conceptual exploration began in the classroom in face-to-face mode. The following questions were posed to the participants as a group discussion question.

1. In which phylum Wuchreria bancrofti belong and which disease is caused by it?
2. Explain the characteristics of Hirudinaria.
3. Differentiate Annelida and Arthropoda with examples.
4. Starfish belong to which phylum, explain the characteristics of it.
5. Differentiate Echinodermata and Hemichordata.

Video-6 Kingdom Animalia (Detailed Classification of Phylum Chordata)

This video started with the introduction of phylum Chordata. The researcher explained the phylum Chordata, its sub phylum and the classes of sub phylum

Figure 3.22

Phylum Chordata

https://youtu.be/YIsDp8GDl6M

Participants watched the videos as many times as they wanted. They come to prepared questions and doubts for asking teacher in classroom sessions.

Day-2 Concept Exploration

On the second day after a gap of 1-day, conceptual exploration began in the classroom in face-to-face mode. The following questions were posed to the participants as a group discussion question.

1. Explain the characteristics of phylum Chordata.
2. Differentiate Protochordata and vertebrata.
3. Why we need to divide phylum into classes.
4. Rana (bull frog) belong to which class explains the characteristics of it.

5. Human being belongs to which kingdom explain their hierarchy of categories.
6. Birds belong to which class explains the characteristics of birds.

3.9.5 Stage-4 Why Do We Fall Ill?

Similarly, the next chapter Why do we fall ill? was prepared and participants were instructed to watch the following videos which were day by day shared on your WhatsApp group.

Table 3.26

Details of Why Do We Fall Ill? Lesson Plan of Lecture Method and Videos of Flipped Classroom

SI.No.	Chapter-4 Why do we fall ill?	Lecture Method	Flipped Classroom
	Topic of the chapter (title of the lesson plan of lecture method and learning material of flipped classroom's text and video	Lesson plan time duration in minutes	Time duration of video in minutes
1.	Health	45	12
2.	Disease	45	13
3.	Infectious disease	45	11
4.	Some disease caused due to infection by microorganism	45	12

Video- 1 Health

This video started with the importance of health. Comparing the human body to a car made me understand the human body is like a complex machine.

Detailed explanation about the conditions necessary for good health like balanced diet, personal and domestic hygiene, and exercise. This video also showed good health habits.

Figure 3.23

Why Do We Fall Ill?

https://youtu.be/pbQNoTAeMqk

Participants watched the videos as many times as they wanted. They come to prepare questions and doubts for asking the teacher in classroom sessions.

Day-2 Concept Exploration

On the second day after a gap of 1-day, conceptual exploration began in the classroom in face-to-face mode. The following questions were posed to the participants as a group discussion question.

1. Why a balanced diet is necessary for good health?

2. Why community health is necessary for personal health?

3. What is a cultural factor and what is the role of social/ cultural factors in our health?

4. Does a disease-free person is healthy or not explain it?

5. In your community people have which type of bad habits and due to these bad habits don't remain healthy.

6. According to you what kind of surroundings will keep you and your family healthy?

7. Why we are normally advised to take bland and nourishing food when we are sick?

Video-2 Disease

This video started with a revision of the previous video. The researcher explained the difference between a healthy and sick person and define what is disease. This video has a detailed description of the causes of disease like drinking unclean water, eating contaminated food, lack of nourishment to the body, economic condition, genetic disorders and many other factors. Type of disease, classification of some common diseases and good habits to prevent disease are also described in this video.

Figure 3.24

Difference Between Sick and Healthy Person

https://youtu.be/FOaeGxHSi4

Participants watched the videos as many times as they wanted. They come to prepare questions and doubts for asking the teacher in a classroom session.

Day-2 Concept Exploration

On the second day after a gap of 1-day, conceptual exploration began in the classroom in face-to-face mode. The following questions were posed to the participants as a group discussion question.

1. What are the main causes of disease in our society/ surroundings?
2. How do environmental pollutants affect our health?
3. How to protect yourself from external factors of disease?
4. How do you identify acute or chronic diseases?
5. A person isolated from his/ her family and friends does he/ she healthy or not describe it?
6. What do you mean by disease symptoms?
7. Prevention of disease is more desirable than its treatment justify the statement.
8. Which 2 habits are very necessary to adopt or quit for good health?

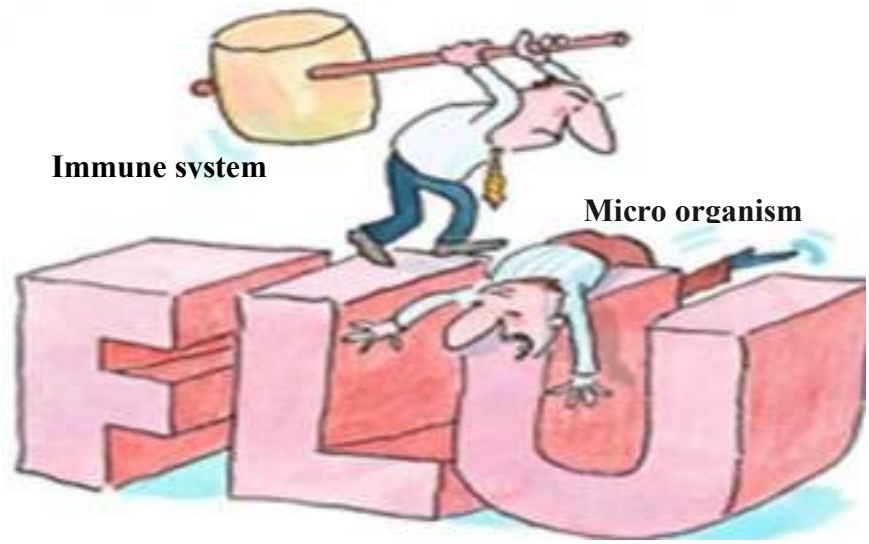
Video-3 Infectious Disease

After revision of the previous video, this video began with the introduction of infectious diseases. Explained the causes of infectious diseases like diseases caused by water, air, insects, food and infectious agents. The researcher also defines in this video means of spread of infectious disease, water borne disease, sexually transmitted disease, fomite borne disease and through

the vector. This video also showed the direct and indirect transmission of disease, actions of antibiotics and rules for the treatment of infectious diseases.

Figure 3.25

General Impacts of Infectious Disease



https://youtu.be/hjDMHUqF_o

Participants watched the videos as many times as they wanted. They come to prepare questions and doubts for asking the teacher in classroom sessions.

Day-2 Concept Exploration

On the second day after a gap of 1-day, conceptual exploration began in the classroom in face-to-face mode. The following questions were posed to the participants as a group discussion question.

1. What is the difference between vaccines and antibiotics?

2. Why are antibiotics not effective for viral diseases?

3. What precautions can you take in your school to reduce the incidence of infectious disease?

4. Why do children need vaccination?

5. How do we prevent infectious diseases?

6. How do infectious agents spread diseases?

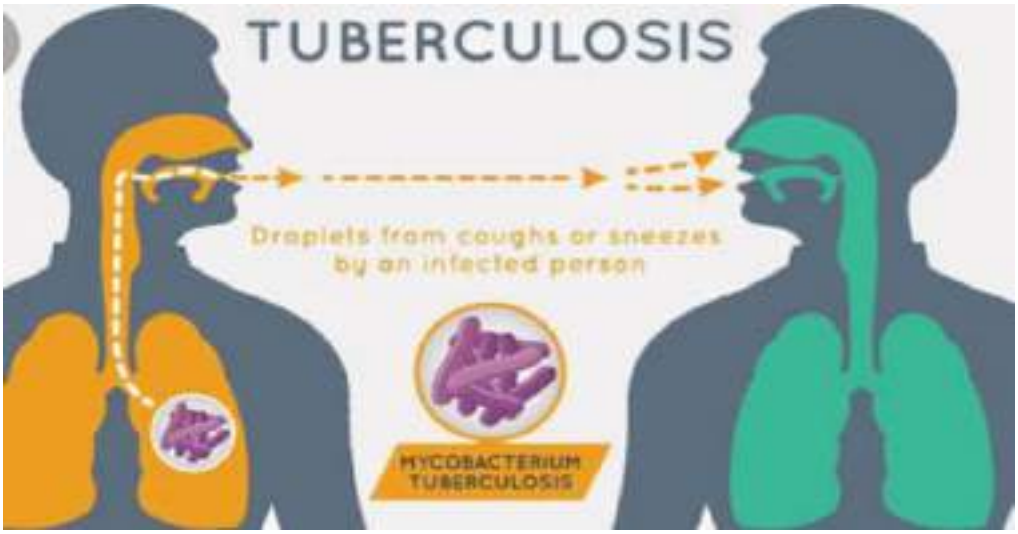
7. What is organ-specific and tissue–specific manifestation of disease?

Video-4 Some Disease Caused due to Infection by Microorganism

This video goes ahead with the introduction of disease caused due to infection by microorganisms. Detail explanations of disease caused by protozoa (malaria), viruses (Influenza and AIDS) and Bacteria (Tuberculosis) and their symptoms, prevention and control were showed the video.

Figure 3.26

Bacterial Infected Disease Tuberculosis



https://yputu.be/eEeKMqfvUjY

Participants watched the videos as many times as they wanted. They come to prepare questions and doubts for asking the teacher in classroom sessions.

Day-2 Concept Exploration

On the second day after a gap of 1-day, conceptual exploration began in the classroom in face-to-face mode. The following questions were posed to the participants as a group discussion question.

1. Why do malaria patients suffer from anemia?

2. Why a person suffering from AIDS becomes prone to many infectious diseases?

3. What are the three most common disease that the people in your locality suffer from?

4. What measures would you take to protect yourself from infectious disease?

5. What are 2 means of physical contact by which AIDS does not spread?

6. What is the method of prevention of tuberculosis?

In this way, total chapters and sub-topics were completed through flipped classroom (distribution of text material, video sharing and group discussion) and parallelly lecture method lesson plans were completed. After that researcher had taken a test of both group control and experimental and both type of school government and private (which are run parallelly) of dependent variables like (Science achievement, Scientific attitude, and Creative thinking). Feed the data and analyze it according to objectives and hypotheses.

3.10 Administration of Tools

The researcher went to selected schools and met the principal/ headmaster and science teacher, especially the biology teacher of IXth class and was aware of their research objectives and their importance. And told them the

whole plan which she wanted to do and took them in confidence. Convince them to permit to conduct the experiment in their school. After taking permission researcher wanted to know about sections of IXth class. And randomized the sections and met the students of selected sections to make the repo with students for the experiment. Before the treatment researcher conducted the test of Socio-Economic Status and Intelligence test to nullify the covariate variables. Science Achievement, Scientific Attitude and Creative Thinking skills test was conducted after the experiment. Scientific Attitude and Science Achievement were self-made tests and creative thinking skills standardized tools by (Baquer mehandi) were selected. Intelligence and socio-economic status were also tested to nullify the covariate variables. The researcher gave the treatment as per the experiment.

3.11 Analysis of Data

Analysis means to break large information into small informative and conclusion forms. Data analysis is defined as interpreting, cleaning, transforming, and modeling for making useful information, conclusion, prediction, explaining relationships, for decision making in the form of a table, graph, chart, or other representation. Many statisticians defined data analysis- Data analysis, according to **Tukey's 1961** definition, includes "procedures for analyzing data, techniques for interpreting the results of such procedures, ways of planning and gathering data to make such analysis easier, more precise, and more accurate, as well as all the machinery and outcomes of (mathematical) statistics that apply to such analysis." **Kaul** defined “studying

the structured information to find underlying facts. To uncover new facts, the data are examined from as many perspectives as is practical". Data analysis helps the researcher to examine the statement of the problem and hypothesis. It helps in keeping away from human bias for the research concluded with the use of proper statistical techniques. Due to the need for this topic researcher used the descriptive and inferential method of data analysis.

3.12 Descriptive Statistics

For this study, as a descriptive statistics researcher used the mean, S. D, skewness and kurtosis.

3.13 Inferential Method

"Based on observations of a sample's characteristics, a statistic is calculated. a parameter's estimated value or its equivalent in the population from which the sample was taken, can be made using a statistic generated from a sample". (Pp. 335 in Best and Kahn). In this method, the sample is taken from a population that represents the population. It allows making predictions (inference) from the data with inferential statistics. Inferential statistics include probability distribution, hypothesis testing, correlation testing, and analysis of variance.

3.14 Statistical Techniques

There were different statistical techniques are used in data analysis according to the data type and method of the data collecting process. In this research to check the assumptions of ANCOVA researcher used Leven's test for homogeneity of variance, for normality researcher used skewness and

kurtosis and correlation to check the relationship between dependent variables and covariates in SPSS 22, and then ANCOVA was used to analyze the data

3.14.1 ANCOVA (analysis of covariance)

The statistical methods known as analysis of covariance allow for the removal of a confounding variable's influence from a study (Best and Kahn pp 404). The analysis of covariance, which is carried out using one or more independent variables and one dependent variable, is a crucial method for evaluating research, particularly those with a quasi-experimental design.

Chapter- 4

Data Analysis and its Interpretation

Chapter-4

DATA ANALYSIS AND ITS INTERPRETATION

The data analysis is the most important aspect of the entire investigation. Raw data have no meaning till it is analyzed in the frame of theory, assumption and hypotheses of the study, which are created before the data is gathered. The researcher tests the hypothesis is supported by the statistical analysis of the data, which also helps interpret the data so that conclusions and generalizations can be drawn. Best & Kahn (2006: 354) "Unambiguously state that the analysis and interpretation of facts reflect the application of deductive and inductive logic to the inquiry". Analysis is the process of dividing a whole study into its component parts and categories in accordance with a specific topic, set of objectives, and set of hypotheses. Regarding the study's findings, the section on interpretation provides an answer to the query. What do the study's findings imply? This is most important section of the research report. In this study Data were in two types, Nominal and interval. Intelligence, SES, Science Achievement, scientific attitude, creative thinking was measured on interval scale while type of school, gender, teaching methods are recorded on nominal scale. Given that this study used a quasi-experimental methodology (Non-equivalent control group post-test only design). The study's primary goal was to assess how flipped classes affected the science performance (science achievement, scientific attitude, and creative thinking) of secondary level pupils. It has treatment variables where method of teaching and science achievement, scientific attitude and creative thinking are taken as

independent variables. Covariates of the study were Intelligence and socio-economic status.

Table 4.1

Level of Variables

SI.No.	Name of Variables	Levels of variable
1	**Creative thinking**	
2	**Intelligence**	Genius
		Very Superior
		Superior
		Bright
		Average
		Dull
		Very dull
		Low
		Mentally retarded
3	**Science Achievement**	Above Average
		Average
		Below Average
4	**Scientific attitude**	Above Average
		Average
		Below Average
5	**Socio-economic Status**	High
		Above Average
		Average
		Below Average
		Low
6	**Teaching methods**	Lecture Method
		Flipped Classroom
7	**Types of school**	Private
		Government

The study design, experiment's method, population, sample, construction and description of the tools, conduction and process of experiment, implementation of a flipped classroom, administration of tool, the process of data collection, statistical techniques were all covered in the earlier chapters. The analysis, interpretation of the data, and discussion of the conclusions are all presented in detail in this chapter. The raw data collected from the experiment was organized and statistically analyzed to test the hypotheses. Data had been analyzed through the computer using MS-Excel 2019 and SPSS 22 of descriptive statistics and inferential statistics for generalization of the interpretation. Parametric inferential statistics (correlation, levene's test of homogeneity of variance, ANCOVA, skewness and kurtosis) were used in the analysis. Before applying these parametric techniques assumption of each were ensured properly. In this chapter data analysis and interpretation were analyzed objective wise.

4.1 Examine the Assumptions of ANCOVA

Similar to traditional ANOVA, ANCOVA is frequently used to identify differences between the means of three or more independent groups while adjusting for scale factors. Other variables that can have an impact on the result can be controlled through ANCOVA.

4.1.1 Assumptions of ANCOVA

a) Correlation between dependent variable and covariate should not be very high (<.80).

b) The dependent variable needs to have a normal distribution.

c) Homogeneity of variance- similar variance between groups. (Analysis of Covariance (ANCOVA) in SPSS https://youtu.be/j6UmlZ62D3E.

4.1.1 a) Check the Correlation Between Dependent and Covariate Variable.

Table 4.2

Correlation Between Dependent Variable (Science Achievement, Scientific Attitude and Creative Thinking) and Covariates (Socio-economic Status and Intelligence)

		SES_score	Intelligence
Science Achievement	Pearson Correlation	.167*	.264**
	Sig. (2-tailed)	.035	.001
	N	160	160
Scientific Attitude	Pearson Correlation	.243**	.010
	Sig. (2-tailed)	.002	.904
	N	160	160
Creative Thinking	Pearson Correlation	.251**	.284**
	Sig. (2-tailed)	.001	.000
	N	160	160

Table 4.2 shows that the correlation between dependent variable (Science achievement, scientific attitude and creative thinking) and covariates (Socio economic status and intelligence) were found to be less than .80. Hence the assumption of correlation of dependent and covariate was fulfilled.

4.1.1 b) To Check the Normality of Dependent Variable

Table 4.3

Test of Normality of Distribution of Dependent Variables

Descriptive Statistics

	N	Min	Max	Mean	S.D	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
Science Achievement	160	6.0	56.0	31.481	11.1152	.144	.192	-.340	.381
Scientific Attitude	160	86.0	185.0	149.469	19.0388	-1.273	.192	2.111	.381
Creativity	160	19.0	185.0	96.600	45.7538	.330	.192	-1.034	.381
Valid N (listwise)	160								

The table 4.3 shows that all distribution of all variables mentioned above were found to be normal. According to these the +/-3 rule of thumb for kurtosis cut- offs. "Acceptable asymmetry and kurtosis values for a normal univariate distribution are those between -2 and +2. (George & Mallery, 2010). Hair et al. (2010) and Bryne (2010) state that data is regarded as normal if the skewness is between -2 and +2 and the kurtosis is between -7 and +7, respectively". Table 4.3 shows that all the dependent variables (Science achievement, Scientific attitude and creative thinking) have the values of skewness is under -2 to +2 and kurtosis is under the -7 to +7. Hence, the assumption of normality was fulfilled of all dependent variables.

4.2 Testing the Hypothesis

$H_0$1-There is no significant difference between the science teaching taught through flipped classroom and that of through lecture method on Science Achievement.

Table 4.4

Number of the Students in both Group

	S.N.	No. of Students
Group	1	80
	2	80

According to Table 4.4, the control group (labeled group 1), which received instruction using the lecture method, contained 80 pupils. The experimental group (labeled group 2) had 80 students and used a flipped classroom method of instruction.

Table 4.5

Descriptive Statistics for Science Achievement Score

Science	Methods of teaching	Mean	S.D.
Achievement	1	31.66	11.026
Score	2	31.30	11.269

Table 4.5 demonstrates that the mean score of science achievement for the group taught through lecture method was 31.66 with standard deviation 11.026. the group taught using flipped classroom had a mean 31.30 with standard deviation 11.269. The test's purpose was to determine whether the experiment group (taught through flipped classroom) would score more than the control group (taught through lecture method). Analysis of covariance (ANCOVA) has been calculated to determine the If there would be a significant difference between the experimental and control groups after taking into account the effect of the covariates on the science achievement score.

Table 4.6

Leven's Test of Homogeneity of Variance for Science Achievement Score

F	df_1	df_2	P	Sig
.193	1	158	0.661	**NS**

For the present data the value of (p= 0.661>0.05) table- 4.6. hence the homogeneity of variance is fulfilled.

Table-4.7

Summary of ANCOVA for impact of Flipped Classroom on Science Achievement when Socio- economic Status is Considered as Covariate.

Source	Type III sum of Squares	df	Mean Square	F	P	Remarks
Corrected model	556.262[a]	2	278.131	2.288	.105	
Intercept	2761.457	1	2761.457	22.714	.000	S

SES_score	551.006	1	551.006	4.532	.035	S
Methods of Teaching	7.404	1	7.404	.061	.805	NS
Error	19087.681	157	121.578			
Total	178215.000	160				
Corrected total	19643.944	159				

R Squared .028 (Adjusted R Squared =.016)

The F-test shown in the separate table 4.7 of ANCOVA is computed on the basis of dependent variable (science achievement score). The type of teaching methods with two levels, flipped classroom and lecture method, are the independent variables. The dependent variable is student's science achievement scores and covariate is the socio-economic status.

The analysis of covariance is not significant, F (y, x) (1,157) = .061, p=0.805>.05 (see table 4.7). The result indicates that there is no significant difference in learning outcomes between students who were taught by flipped classroom model (M=31.3) and students who were taught using the lecture (M= 31.66) See table 4.5 having controlled for the effect of their socio-economic status (covariate). Therefore, the null hypothesis 'There is no significant difference between the science achievement (secondary level students) taught through flipped classroom and that of through lecture method' has been not rejected. This suggests that both the lecture technique and the flipped classroom were found to be equally successful in raising students' science achievement. When their socio-economic status was taken as covariate.

Table 4.8

Leven's test of Homogeneity of Variance for Science Achievement Score

F	df_1	df_2	P	Remark
.000	1	158	.991	**NS**

For the present data the value of (p= 0.991>0.05). hence the homogeneity of variance assumption is fulfilled.

Table 4.9

Summary of ANCOVA for Effect of Flipped Classroom on Science Achievement when Intelligence is Considered as Covariate.

Source	Type III Sum of Squares	df	Mean Square	F	P	Remark
Corrected Model	1375.767[a]	2	687.884	5.912	.003	S
Intercept	5787.192	1	5787.192	49.736	.000	S
intelligence	1370.511	1	1370.511	11.778	.001	S
Method of teaching	6.405	1	6.405	.055	.815	**NS**
Error	18268.177	157	116.358			
Total	178215.000	160				

Corrected Total	19643.944	159				

a. R Squared = .070 (Adjusted R Squared = .058)

The F-test shown in the separate table 4.9 of ANCOVA is computed on the basis of dependent variable (science achievement score). The type of teaching methods with two levels, flipped classroom and lecture method, are the independent variables. The dependent variable is student's science achievement scores and covariate is the intelligence.

The analysis of covariance is not significant, F (y, x) (1,157) = .055, p=0.815>.05 (see table 4.9). the result shows that there is no significant difference between students, who were taught by flipped classroom (M= 31.3) and students who were taught by lecture method (M= 31.66) (see table- 4.5) having controlled for the effect of their intelligence (covariate) therefore, the null hypothesis 'There is no significant difference between the science achievement (secondary level students) taught through flipped classroom and that of through lecture method' has been not rejected. This leads to the interpretation that both flipped classroom and lecture method were establish to be similarly effective in terms of students' science achievement. if intelligence was considered a covariate.

$H_0$2- There is no significant difference between the level of scientific attitude (secondary level students) taught through flipped classroom and that of through lecture method.

Table 4.10

Descriptive Statistics for Scientific Attitude Score

Scientific Attitude	Methods of teaching	Mean	S.D.
	1	144.213	21.33
	2	154.725	14.77

Table- 4.10 makes it evident that the mean score of scientific attitude for the group taught through lecture method was 144.213 with standard deviation 21.33. the group taught using flipped classroom had a mean 154.725 with standard deviation 14.77.

Table 4.11

Leven's test of Homogeneity of Variance for Scientific Attitude Score

F	df_1	df_2	P	Sig
11.724	1	158	.001	**S***

For the present data the value of ($p= 0.001<0.05$). hence the homogeneity of variance assumption is not fulfilled. Andy Field (2012) Jane super brain 5.6, The homogeneity of variance is violated regardless of whether you have an equal group size and large samples (Lokesh Kaul, 2009) defines samples of 30 or more as large samples and samples of less than 30 as small samples.

Table 4.12

Summary of ANCOVA for Effect of Flipped Classroom on Scientific Attitude When Socio Economic Status Was Considered as Covariate.

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Remarks
Corrected Model	7677.808[a]	2	3838.904	12.065	.000	S
Intercept	91739.812	1	91739.812	288.317	.000	S
SES_score	3257.301	1	3257.301	10.237	.002	S
Method of teaching	4281.543	1	4281.543	13.456	.000	**S**
Error	49956.036	157	318.191			
Total	3632179.000	160				
Corrected Total	57633.844	159				

a. R Squared = .133 (Adjusted R Squared = .122)

The F-test shown in the separate table 4.12 of ANCOVA is computed on the basis of dependent variable (scientific attitude score). The type of teaching methods with two levels, flipped classroom and lecture method, are the independent variables. The dependent variable is student's scientific attitude scores and covariate is the socio-economic status.

The analysis of covariance is significant, F (y, x) (1,157) = 13.456, p=0.000<.05 (see table 4.12). The outcome demonstrates that students who were taught using the flipped classroom model and those who were taught using the lecture method differ significantly having controlled for the effect of their socio- economic status (covariate) therefore, the null hypothesis 'There is no significant difference between the scientific attitude (secondary level students) taught through flipped classroom and that of through lecture method' has been rejected. Further the mean score of flipped classroom (154.725) which is significantly higher than those of

lecture method (144.213) (see table- 4.10) when their socio- economic status was taken as covariate. It may be said that flipped classroom students had more scientific attitude as compared to lecture method students. When their socio-economic status was taken as covariate.

Table 4.13

Leven's Test of Homogeneity of Variance for Scientific Attitude Score

F	df_1	df_2	P	Sig
12.184	1	158	.001	**S***

For the present data the value of (p= 0.001<0.05). hence the homogeneity of variance assumption is not fulfilled. Andy Field (2012), Jane super brain 5.6, It doesn't matter if the homogeneity of variance is broken if you have an equal group size and large samples (Lokesh Kaul, 2009 defines samples of 30 or more as large samples and samples of less than 30 as small samples).

Table 4.14

Summary of ANCOVA for Effect of Flipped Classroom on Scientific Attitude When Intelligence is Considered as Covariate.

Source	Type III Sum of Squares	Df	Mean Square	F	P	Remark
Corrected Model	4424.003[a]	2	2212.002	6.527	.002	S
Intercept	278905.523	1	278905.523	822.934	.000	S
Intelligence	3.497	1	3.497	.010	.919	NS

Method of teaching	4418.724	1	4418.724	13.038	.000	**S**
Error	53209.841	157	338.916			
Total	3632179.000	160				
Corrected Total	57633.844	159				

a. R Squared = .077 (Adjusted R Squared = .065)

The F-test shown in the separate table 4.14 of ANCOVA is computed on the basis of dependent variable (scientific attitude score). The type of teaching methods with two levels, flipped classroom and lecture method, are the independent variables. The dependent variable is student's scientific attitude scores and covariate is the intelligence.

The analysis of covariance is not significant, F (y, x) (1,157) = 13.038, p=0.000<.05 (see table 4.14). the result shows that there is significant difference between students, who were taught by flipped classroom and students who were taught by lecture method having controlled for the effect of their intelligence (covariate). Thus, the null hypothesis There is no significant difference between the scientific attitude (secondary level students) taught through flipped classroom and that of through lecture method' has been rejected. Further the mean score of flipped classroom (154.725) which is significantly higher than those of lecture method (144.213) (see table- 4.10) when their intelligence was taken as covariate. It may be said that flipped classroom students had more scientific attitude as compared to lecture method students. When their intelligence was taken as covariate.

$H_0$3- There is no significant difference between the science teaching taught through flipped classroom and that of through lecture method on Creative thinking.

Table 4.15

Descriptive Statistics for Creative Thinking Score

Creative Thinking	Methods of teaching	Mean	S.D.
	1	95.787	45.99
	2	97.413	45.78

Table 4.15 makes it quite evident that the mean score of creative thinking for the group taught through lecture method was 95.787 with standard deviation 45.99. the group taught using flipped classroom had a mean 97.41 with standard deviation 45.78.

Table 4.16

Leven's Test of Homogeneity of Variance for Creative Thinking Score

F	df_1	df_2	P	Sign
.856	1	158	.356	**NS**

For the present data in table 4.16 the value of (p= 0.356>0.05). hence the homogeneity of variance assumption is fulfilled.

Table 4.17

Summary of ANCOVA for Effect of Flipped Classroom on Creative Thinking When Socio-Economic Status is Considered as Covariate.

Source	Type III Sum of Squares	Df	Mean Square	F	P	Remark
Corrected Model	21092.568[a]	2	10546.284	5.311	.006	S
Intercept	8051.870	1	8051.870	4.055	.046	S
SES_score	20986.943	1	20986.943	10.569	.001	S
Method of teaching	58.217	1	58.217	.029	.864	**NS**
Error	311759.832	157	1985.731			
Total	1825902.000	160				
Corrected Total	332852.400	159				

a. R Squared = .063 (Adjusted R Squared = .051)

The F-test shown in the separate table 4.17 of ANCOVA is computed on the basis of dependent variable (creative thinking score). The type of teaching methods with two levels, flipped classroom and lecture method, are the independent variables. The dependent variable is student's creative thinking scores and covariate is the socio-economic status.

The analysis of covariance is not significant, F (y, x) (1,157) = .029, p=0.864>.05 (see table 4.17). the result shows that there is no significant difference between students, who were taught by flipped classroom (M= 97.41) and students who were

taught by lecture method (M= 95.78) (see table 4.15) having controlled for the effect of their socio- economic status (covariate) therefore, the null hypothesis 'There is no significant difference between the creative thinking (secondary level students) taught through flipped classroom and that of through lecture method' has been not rejected. This leads to the interpretation that both flipped classroom and lecture method were found to be uniformly effective in terms of creative thinking of students. When their socio- economic status was taken as covariate.

Table 4.18

Leven's Test of Homogeneity of Variance for Creative Thinking Score

F	df_1	df_2	P	Remark
1.341	1	158	.249	**NS**

Table 4.18 the value of (p= 0.249>0.05). hence the homogeneity of variance assumption is fulfilled.

Table 4.19

Summary of ANCOVA for Effect of Flipped Classroom on Creative Thinking When Intelligence is Considered as Covariate.

Source	Type III Sum of Squares	Df	Mean Square	F	p	Remark
Corrected Model	26867.365[a]	2	13433.682	6.893	.001	S

Intercept	34388.677	1	34388.677	17.64	.000	S
intelligence	26761.740	1	26761.74	13.73	.000	S
Method of teaching	85.098	1	85.098	.044	.835	**NS**
Error	305985.035	157	1948.949			
Total	1825902.00	160				
Corrected Total	332852.400	159				

a. R Squared = .081 (Adjusted R Squared = .069)

The F-test shown in the separate table 4.19 of ANCOVA is computed on the basis of dependent variable (creative thinking score). The type of teaching methods with two levels, flipped classroom and lecture method, are the independent variables. The dependent variable is student's creative thinking scores and covariate is the intelligence.

The analysis of covariance is not significant, F (y, x) (1,157) = .044, p=0.835>.05 (see table 4.19). Students who were taught using the flipped classroom (M= 97.41) and students who were taught using the lecture method don't differ much, according to the results. (M= 95.78) (see table 4.15) having controlled for the effect of their intelligence (covariate) therefore, the null hypothesis 'There is no significant difference between the creative thinking (secondary level students) taught through flipped classroom and that of through lecture method' has been not rejected. This leads to the interpretation that both flipped classroom and lecture method were

found to be equivalently effective in terms of creative thinking of students. When their intelligence was considered as covariate.

$H_0$4- There is no significant difference between the level of science achievement of Government secondary level students taught through flipped classroom and that of through lecture method.

Table 4.20

Number of the Students in Government Secondary Level Students According to Methods of Teaching.

Government	Methods of teaching	No. of Students
Secondary level Students	1	40
	2	40

According to Table 4.20 control group (labeled group 1) consisted 40 students who were taught through lecture method and 40 students of experimental group (labeled group 2) who were taught through flipped classroom of government secondary level students.

Table 4.21

Descriptive Statistics for Science Achievement Score of Government Secondary Level Students.

Science	Methods of teaching	Mean	S.D.
Achievement Score	1	26.40	8.68
	2	25.75	9.96

Table- 4.21 makes it very clear that the average score of science achievement of government secondary level students for the group taught through lecture method was 26.40 with standard deviation 8.68. the group taught using flipped classroom had a mean 25.75 with standard deviation 9.96.

Table 4.22

Leven's Test of Homogeneity of Variance for Science Achievement Score of Government Secondary Level Students.

F	df_1	df_2	P	Remark
.571	1	78	.452	**NS**

Present table 4.22 the value of (p= 0.452>0.05). that why the homogeneity of variance presumption is fulfilled.

Table 4.23

Summary of ANCOVA for impact of Flipped Classroom on Science Achievement of Government Secondary Level Students When Socio Economic Status is Considered as Covariate.

Source	Type III Sum of Squares	df	Mean Square	F	P	Remark
Corrected Model	288.037[a]	2	144.018	1.697	.190	NS
Intercept	1006.029	1	1006.029	11.856	.001	S

SES_score	279.587	1	279.587	3.295	.073	NS
Method of teaching	4.484	1	4.484	.053	.819	**NS**
Error	6533.513	77	84.851			
Total	61214.000	80				
Corrected Total	6821.550	79				

a. R Squared = .042 (Adjusted R Squared = .017)

The F-test shown in the separate table 4.23 of ANCOVA is computed on the basis of dependent variable (science achievement score). The type of teaching methods with two levels, flipped classroom and lecture method, are the independent variables. The dependent variable is student's science achievement scores of government secondary level students and covariate is the socio-economic status.

The analysis of covariance is not significant, F (y, x) (1,77) = .053, p=0.819>.05 (see table 4.23). the result revealed that there have no significant difference between students, who were instructed by flipped classroom (M=25.75) and students who taught by lecture method (M=26.40) (see 4.21) having controlled for the effect of their socio- economic status (covariate) therefore, the null hypothesis 'There is no significant difference between level of science achievement (Government secondary level students) taught through flipped classroom and that of through lecture method' has been not rejected. This leads to the interpretation that both flipped classroom and lecture method were identical effective with regard to

science achievement of Government secondary level students. When their socio-economic status was taken as covariate.

Table 4.24

Leven's Test of Homogeneity of Variance for Science Achievement of Government Secondary Level Students.

F	df_1	df_2	P	Remark
1.349	1	78	.249	**NS**

For the present data the value of (p= 0.249>0.05). hence the homogeneity of variance assumption is fulfilled.

Table – 4.25

Summary of ANCOVA for Flipped Classroom impact on Science Achievement of Government Secondary Level Students When Intelligence is Considered as Covariate.

Source	Type III Sum of Squares	Df	Mean Square	F	p	Remark
Corrected Model	703.053[a]	2	351.526	4.424	.015	S
Intercept	1637.666	1	1637.66	20.61	.000	S
Intelligence	694.603	1	694.603	8.741	.004	S
Method of Teaching	31.329	1	31.329	.394	.532	**NS**

Error	6118.497	77	79.461			
Total	61214.000	80				
Corrected Total	6821.550	79				

a. R Squared = .103 (Adjusted R Squared = .080)

The F-test shown in the separate table 4.25 of ANCOVA is computed on the basis of dependent variable (science achievement score). The type of teaching methods with two levels, flipped classroom and lecture method, are the independent variables. The dependent variable is student's science achievement scores of government secondary level students and covariate is the intelligence.

The analysis of covariance is not significant, F (y, x) (1,77) = .0394, p=0.532>.05 (see table 4.25). the result express that flipped classroom (M=25.75) students have no significant difference compare to those who were taught by lecture method (M=26.40) (see table 4.21) having controlled for the effect of their intelligence (covariate) therefore, the null hypothesis 'There is no significant difference between level of science achievement (Government secondary level students) taught through flipped classroom and that of through lecture method' has been not rejected. This leads to the interpretation that both flipped classroom and lecture method were found to be equivalently effective in terms of science achievement of Government secondary level pupils. When their intelligence taken as covariate.

$H_0$5- There is no significant difference between the level of science achievement of Private secondary level students taught through flipped classroom and that of through lecture method.

Table 4.26

Number of the Students in Private Secondary Level Students According to Methods of Teaching.

Private	Methods of teaching	No. of Students
Secondary level Students	1	40
	2	40

According to Table 4.26, the control group (labeled group 1), which received lectures as instruction, consisted of 40 pupils. 40 students of experimental group (labeled group 2) who were taught through flipped classroom of private secondary level students.

Table 4.27

Descriptive Statistics for Science Achievement Score of Private Secondary Level Students.

Science	Methods of teaching	Mean	S.D.
Achievement Score	1	36.925	10.67
	2	36.85	9.73

From table- 4.27 mean score of science achievement of private secondary level students for the group taught through lecture method was 36.925 with standard deviation 10.67. the group taught using flipped classroom had a mean 36.85 with standard deviation 9.73.

Table 4.28

Leven's test of Homogeneity of Variance for Science Achievement Score of Secondary Level Private Students

F	df_1	df_2	P	Remark
.066	1	78	.798	**NS**

For the present data the value of (p= 0.798>0.05). so, the homogeneity of variance assumption is fulfilled.

Table 4.29

Summary of ANCOVA for Effect of Flipped Classroom on Science Achievement of Secondary Level Private Students When Socio Economic Status is Considered as Covariate.

Source	Type III Sum of Squares	Df	Mean Square	F	p	Remark
Corrected Model	1.999[a]	2	1.000	.009	.991	NS
Intercept	3196.886	1	3196.88	30.226	.000	S
SES score	1.887	1	1.887	.018	.894	NS
Method of teaching	.042	1	.042	.000	.984	**NS**
Error	8143.988	77	105.766			
Total	117001.000	80				

Corrected Total	8145.987	79				

a. R Squared = .000 (Adjusted R Squared = -.026)

The F-test shown in the separate table 4.29 of ANCOVA is computed on the basis of dependent variable (science achievement score). The type of teaching methods with two levels, flipped classroom and lecture method, are the independent variables. The dependent variable is student's science achievement scores of private secondary level students and covariate is the socio-economic status.

The analysis of covariance is not significant, F (y, x) (1,77) = .000, p=0.984>.05 (see table 4.29). Students who were taught using the flipped classroom (M=36.85) and students who were taught using the lecture technique (M=36.925) did not differ significantly, according to the findings. (See table 4.27) having controlled for the effect of their socio- economic status (covariate) therefore, the null hypothesis 'There is no significant difference between level of science achievement (private secondary level students) taught through flipped classroom and that of through lecture method' has been not rejected. This leads to the interpretation that both flipped classroom and lecture method were equally effective for science achievement of Private secondary level students. When their socio-economic status was taken as covariate.

Table 4.30

Leven's Test of Homogeneity of Variance for Science Achievement Score of Secondary Level Private Students

F	df_1	df_2	P	Remarks
.037	1	78	.848	**NS**

For the present data the value of (p= 0.848>0.05). thus, the homogeneity of variance assumption is fulfilled.

Table 4.31

Summary of ANCOVA for Effect of Flipped Classroom on Science Achievement of Secondary Level Private Students When Intelligence is Considered as Covariate.

Source	Type III Sum of Squares	df	Mean Square	F	P	remark
Corrected Model	10.536[a]	2	5.268	.050	.951	NS
Intercept	7345.223	1	7345.223	69.521	.000	S
Intelligence	10.423	1	10.423	.099	.754	NS
Method_of_teaching	.364	1	.364	.003	.953	**NS**
Error	8135.452	77	105.655			
Total	117001.000	80				
Corrected Total	8145.987	79				

a. R Squared = .001 (Adjusted R Squared = -.025)

The F-test shown in the separate table 4.31 of ANCOVA is computed on the basis of dependent variable (science achievement score). The type of teaching methods with two levels, flipped classroom and lecture method, are the independent

variables. The dependent variable is student's science achievement scores of private secondary level students and covariate is the intelligence.

The analysis of covariance is not significant, F (y, x) (1,77) = .003, p=0.953>.05 (see table 4.31). the result shows that flipped classroom (M=36.85) and lecture method (M=36.925) students has no significant difference. (See table 4.27) having controlled for the effect of their intelligence (covariate) therefore, the null hypothesis 'There is no significant difference between level of science achievement (private secondary level students) taught through flipped classroom and that of through lecture method' has been not rejected. This leads to the interpretation that both flipped classroom and lecture method were similar in terms of science achievement of Private secondary level students. When their intelligence was taken as covariate.

$H_0$6- There is no significant difference between the level of scientific attitude of Government secondary level students taught through flipped classroom and that of through lecture method.

Table 4.32

Number of the Students in Government Secondary Level Students According to Teaching Methods.

Government	Methods of teaching	No. of Students
Secondary level Students	1	40
	2	40

According to Table 4.32, the control group (labeled group 1), which received lectures as instruction, consisted 40 pupils and experimental group (labeled group 2), of 40 students who were taught through flipped classroom of private secondary school pupils.

Table 4.33

Descriptive Statistics for Scientific Attitude Score of Secondary Level Government Students.

Scientific	Methods of teaching	Mean	S.D.
Attitude	1	146.725	25.055
Score	2	149.700	15.966

From table- 4.33 that the mean score of scientific attitudes of government secondary level students for the group taught through lecture method was 146.725 with standard deviation 25.055. the group taught using flipped classroom had a mean 149.7 with standard deviation 15.966.

Table 4.34

Leven's Test of Homogeneity of Variance for Scientific Attitude Score of Secondary Level Government Students

F	df_1	df_2	P	Remark
3.554	1	78	.063	**NS**

For the present data the value of (p= 0.063>0.05). then the homogeneity of variance assumption is fulfilled.

Table 4.35

Summary of ANCOVA for Effect of Flipped Classroom on Scientific Attitude of Secondary Level Government Students When Socio- Economic Status is Considered as Covariate.

Source	Type III Sum of Squares	Df	Mean Square	F	P	Remark
Corrected Model	3275.377[a]	2	1637.688	4.025	.022	S
Intercept	47882.814	1	47882.814	117.689	.000	S
SES score	3098.364	1	3098.364	7.615	.007	S
Method of teaching	253.033	1	253.033	.622	.433	**NS**
Error	31328.011	77	406.857			
Total	1791959.000	80				
Corrected Total	34603.387	79				

a. R Squared = .095 (Adjusted R Squared = .071)

The F-test shown in the separate table 4.35 of ANCOVA is computed on the basis of dependent variable (scientific attitude score). The type of teaching methods with

two levels, flipped classroom and lecture method, are the independent variables. The dependent variable is student's scientific attitude scores of government secondary level students and covariate is the socio- economic status.

The analysis of covariance is not significant, F (y, x) (1,77) = .622, p=0.433>.05 (see table 4.35). the result explains that students who were taught by flipped classroom (M=149.7) and those who were taught by lecture method (M=146.725) have no significantly differ (see table 4.33) having controlled for the effect of their socio- economic status (covariate) therefore, the null hypothesis 'There is no significant difference between level of scientific attitude (government secondary level students) taught through flipped classroom and that of through lecture method' has been not rejected. This leads to the interpretation that both flipped classroom and lecture method were identical in terms of scientific attitude of government secondary level students. When their socio-economic status was taken as covariate.

Table 4.36

Leven's Test of Homogeneity of Variance for Scientific Attitude Score of Secondary Level Government Students

F	df_1	df_2	P	Remark
4.738	1	78	.033	**S**

For the present data the value of (p= 0.033<0.05). hence the homogeneity of variance assumption is not fulfilled. Andy Field (2012), Jane super brain 5.6, if you

have equal group size and large samples (samples of 30 or more consider as a large sample and less than 30 are taken as small samples (Lokesh Kaul, 2009) it doesn't matter the homogeneity of variance is violated or not.

Table 4.37

Summary of ANCOVA for Effect of Flipped Classroom on Scientific Attitude of Secondary Level Government Students When Intelligence is Considered as Covariate.

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Remark
Corrected Model	201.845[a]	2	100.922	.226	.798	NS
Intercept	143287.744	1	143287.744	320.717	.000	S
Intelligence	24.832	1	24.832	.056	.814	NS
Method of teaching	188.949	1	188.949	.423	.517	**NS**
Error	34401.543	77	446.773			
Total	1791959.000	80				
Corrected Total	34603.387	79				

a. R Squared = .006 (Adjusted R Squared = -.020)

The F-test shown in the separate table 4.37of ANCOVA is computed on the basis of dependent variable (scientific attitude score). The type of teaching methods with two levels, flipped classroom and lecture method, are the independent variables. The dependent variable is student's scientific attitude scores of government secondary level students and covariate is the intelligence.

The analysis of covariance is not significant, F (y, x) (1,77) = .423, p=0.517>.05 (see table 4.37). the result express that both group's students has no significant difference who were taught by flipped classroom (M=149.7) and those who were taught by lecture method (M=146.725) (see table 4.33) having controlled for the effect of their intelligence (covariate) therefore, the null hypothesis 'There is no significant difference between level of scientific attitude (government secondary level students) taught through flipped classroom and that of through lecture method' has been not rejected. This leads to the interpretation that both flipped classroom and lecture method were equal in terms of scientific attitude of government secondary level students. When their intelligence was taken as covariate.

$H_0$7- There is no significant difference between the level of scientific attitude of Private secondary level students taught through flipped classroom and that of through lecture method.

Table 4.38

Number of the Students in Secondary Level Private Students According to Methods of Teaching.

Private	Methods of teaching	No. of Students
Secondary level	1	40
Students	2	40

According to Table 4.38, the control group (labeled group 1) consisted 40 students taught through lecture method. An experimental group (labeled group 2), instructed by flipped classroom of 40 students of private secondary level pupils.

Table 4.39

Descriptive Statistics for Scientific Attitude Score of Secondary Level Private Students.

Scientific attitude Score	Methods of teaching	Mean	S.D.
	1	141.7	16.77
	2	159.75	11.64

Table 4.39 makes it evident that the mean score of a scientific attitude of private secondary level students for the group taught through lecture method was 141.7 with standard deviation 16.77. the group taught using flipped classroom had a mean 159.75with standard deviation 11.64.

Table 4.40

Leven's Test of Homogeneity of Variance for Scientific Attitude Score of Secondary Level Private Students

F	df_1	df_2	P	Remark
4.633	1	78	.034	**S***

The value of ($p=0.034<0.05$) applies to the current data. In light of this, the homogeneity of variance assumption is not met. According to Andy Field (2012), Jane super brain 5.6, it doesn't matter if the homogeneity of variance is broken if you have an equal group size and large samples (samples of 30 or more are

considered large samples, whereas samples of less than 30 are considered small samples according to Lokesh Kaul, 2009).

Table 4.41

Summary of ANCOVA for Effect of Flipped Classroom on Scientific Attitude of Secondary Level Private Students When Socio- Economic Status is Considered as Covariate.

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Remark
Corrected Model	6742.342[a]	2	3371.171	16.188	.000	S
Intercept	44380.083	1	44380.083	213.105	.000	S
SES_score	226.292	1	226.292	1.087	.300	NS
Method of teaching	6231.225	1	6231.225	29.921	.000	**S**
Error	16035.608	77	208.255			
Total	1840220.000	80				
Corrected Total	22777.950	79				

a. R Squared = .296 (Adjusted R Squared = .278)

The F-test shown in the separate table 4.41 of ANCOVA is computed on the basis of dependent variable (scientific attitude score). The type of teaching methods with two levels, flipped classroom and lecture method, are the independent variables. The dependent variable is student's scientific attitude scores of private secondary level students and covariate is the socio- economic status.

The analysis of covariance is not significant, F (y, x) (1,77) = 29.921, p=0.000<.05 (see table 4.41.) After accounting for the impact of the students' socioeconomic status, (covariate) the findings reveal a substantial difference between students who were taught using the flipped classroom technique and those who were taught using the lecture method. Thus, the null hypothesis There is no significant difference between the scientific attitude (private secondary level students) taught through flipped classroom and that of through lecture method' has been rejected. Further the mean score of flipped classroom (159.75) which is significantly higher than those of lecture method (141.7) (see table- 4.39) when their socio-economic status was taken as covariate. It may be said that flipped classroom students had more scientific attitude as compared to lecture method students. When their socio-economic status was taken as covariate.

Table 4.42

Leven's Test of Homogeneity of Variance for Scientific Attitude Score of Secondary Level Private Students

F	df_1	df_2	P	Remark
5.300	1	78	.024	**S***

For the present data the value of (p= 0.024<0.05). In light of this, the homogeneity of variance assumption is not met. According to Andy Field (2012), Jane super brain 5.6, it doesn't matter if the homogeneity of variance is not fulfilled, if you have an equal group size and large samples (samples of 30 or more are considered

large samples, whereas samples of less than 30 are considered small samples according to Lokesh Kaul, 2009).

Table 4.43

Summary of ANCOVA for Effect of Flipped Classroom on Scientific Attitude of Secondary Level Private Students When Intelligence is Considered as Covariate.

Source	Type III Sum of Squares	Df	Mean Square	F	P	Remark
Corrected Model	6550.625[a]	2	3275.312	15.542	.000	S
Intercept	110044.021	1	110044.021	522.168	.000	S
Intelligence	34.575	1	34.575	.164	.687	NS
Method of teaching	6549.884	1	6549.884	31.080	.000	**S**
Error	16227.325	77	210.744			
Total	1840220.000	80				
Corrected Total	22777.950	79				

a. R Squared = .288 (Adjusted R Squared = .269)

The F-test shown in the separate table 4.43 of ANCOVA is computed on the basis of dependent variable (scientific attitude score). The type of teaching methods with two levels, flipped classroom and lecture method, are the independent variables. The dependent variable is student's scientific attitude scores of private secondary level students and covariate is the intelligence.

The analysis of covariance is significant, F (y, x) (1,77) = 31.080, p=0.000<.05 (see table 4.43). the result shows that there is significant difference between students, who were taught by flipped classroom and students who were taught by lecture method having controlled for the effect of their intelligence (covariate). Thus, the null hypothesis There is no significant difference between the scientific attitude (private secondary level students) taught through flipped classroom and that of through lecture method' has been rejected. Further the mean score of flipped classroom (159.75) which is significantly higher than those of lecture method (141.7) (see table- 4.39) when their intelligence was taken as covariate. It may be said that flipped classroom students had more scientific attitude as compared to lecture method students. When their intelligence was taken as covariate.

$H_0$8- There is no significant difference between the level of Creative thinking of Government secondary level students taught through flipped classroom and that of through lecture method.

Table 4.44

Number of the Students in Secondary Level Government Students According to Methods of Teaching.

Government	Methods of teaching	No. of Students
Secondary level Students	1	40
	2	40

According to Table 4.44, the control group (labeled group 1) consisted of 40 students and used the lecture mode of instruction. Experimental group (labeled group 2) of 40 students who were studying government at the secondary level.

Table 4.45

Descriptive Statistics for Creative Thinking Score of Secondary Government Level Students.

Creative Thinking Score	Methods of teaching	Mean	S.D.
	1	96.625	46.26
	2	87.325	48.03

From table- 4.45, it is clear that the average score of creative thinking of government secondary level students for the group taught through lecture method was 96.62 with standard deviation 46.26. the group taught using flipped classroom had a mean 87.32 with standard deviation 48.03.

Table 4.46

Leven's test of Homogeneity of Variance for Creative Thinking Score of Secondary Level Government Students

F	df_1	df_2	P	Remark
.712	1	78	.401	**NS**

For the present data the value of (p= 0.401>0.05). hence the homogeneity of variance assumption is satisfied.

Table 4.47

Summary of ANCOVA for Effect of Flipped Classroom on Creative Thinking of Secondary Level Government Students When Socio-Economic Status is Considered as Covariate.

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Remark
Corrected Model	23750.005[a]	2	11875.003	6.038	.004	
Intercept	594.773	1	594.773	.302	.584	
SES score	22020.205	1	22020.205	11.197	.001	S
Method of teaching	1194.941	1	1194.941	.608	.438	**NS**
Error	151433.945	77	1966.675			
Total	851936.000	80				
Corrected Total	175183.950	79				

a) R Squared = .136 (Adjusted R Squared = .113)

The F-test shown in the separate table 4.47 of ANCOVA is computed on the basis of dependent variable (creative thinking score). The type of teaching methods with two levels, flipped classroom and lecture method, are the independent variables. The dependent variable is student's creative thinking scores of government secondary level students and covariate is the socio-economic status.

The analysis of covariance is not significant, F (y, x) (1,77) = .608, p=0.438>.05 (see table 4.47). the result shows that there is no significant difference between students, who were taught by flipped classroom (M=87.325) and students who were

taught by lecture method (M=96.625) (see table 4.45) having controlled for the effect of their socio- economic status (covariate) therefore, the null hypothesis 'There is no significant difference between level of creative thinking (government secondary level students) taught through flipped classroom and that of through lecture method' has been not rejected. This leads to the interpretation that both flipped classroom and lecture method were found to be similarly effective in terms of creative thinking of government secondary level students. When their socio-economic status was taken as covariate.

Table 4.48

Leven's test of Homogeneity of Variance for Creative Thinking Score of Secondary Level Government Students

F	df_1	df_2	P	Remark
.763	1	78	.385	**NS**

For the present data the value of (p= 0.385>0.05). therefore, the homogeneity of variance assumption is reached.

Table 4.49

Summary of ANCOVA for Effect of Flipped Classroom on Creative Thinking of Secondary Level Government Students When Intelligence is Considered as Covariate.

Source	Type III Sum of Squares	df	Mean Square	F	p	Remark
Corrected Model	30513.347[a]	2	15256.673	8.120	.001	
Intercept	4783.382	1	4783.382	2.546	.115	
intelligence	28783.547	1	28783.547	15.320	.000	S
Method of teaching	3456.065	1	3456.065	1.839	.179	**NS**
Error	144670.603	77	1878.839			
Total	851936.000	80				
Corrected Total	175183.950	79				

a. R Squared = .174 (Adjusted R Squared = .153)

The F-test shown in the separate table 4.49 of ANCOVA is computed on the basis of dependent variable (creative thinking score). The type of teaching methods with two levels, flipped classroom and lecture method, are the independent variables. The dependent variable is student's creative thinking scores of government secondary level students and covariate is the intelligence.

The analysis of covariance is not significant, F (y, x) (1,77) = 1.839, p=0.179>.05 (see table 4.49). the result revealed that there is no significant difference between students, who were taught by flipped classroom (M=87.325) and students who were taught by lecture method (M=96.625) (see table 4.45) having controlled for the effect of their intelligence (covariate) therefore, the null hypothesis 'There is no significant difference between level of creative thinking (government secondary level students) taught through flipped classroom and that of through lecture

method' has been not rejected. This leads to the interpretation that both flipped classroom and lecture method were identically effective in terms of creative thinking of government secondary level students. When their intelligence was taken as covariate.

$H_0$9- There is no significant difference between the level of Creative thinking of Private secondary level students taught through flipped classroom and that of through lecture method.

Table 4.50

Number of the Students in Secondary Level Private Students According to Methods of Teaching.

Private	Methods of teaching	No. of Students
Secondary level Students	1	40
	2	40

Table 4.50 shows that 40 students of control group (labeled group 1) who were taught through lecture method of teaching. 40 students of experimental group (labeled group 2) who were taught through flipped classroom of private secondary level students.

Table 4.51

Descriptive Statistics for Creative Thinking Score of Secondary Level Private Students.

Creative Thinking Score	Methods of teaching	Mean	S.D.
	1	94.95	46.30
	2	107.5	41.59

From table- 4.51, it is explain that the mean score of creative thinking of private secondary level students for the group taught through lecture method was 94.95 with standard deviation 46.30. the group taught using flipped classroom had a mean 107.5 with standard deviation 41.59.

Table 4.52

Leven's test of Homogeneity of Variance for Creative Thinking Score of Secondary Level Private Students

F	df_1	df_2	P	Sign
.155	1	78	.695	**NS**

For the present data the value of (p= 0.695>0.05). thus, the homogeneity of variance assumption is met.

Table 4.53

Summary of ANCOVA Table Effect of Flipped Classroom on Creative Thinking of Secondary Level Private Students When Socio-Economic Status is Considered as Covariate.

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Remark

Corrected Model	4083.116[a]	2	2041.558	1.047	.356	
Intercept	14719.769	1	14719.769	7.548	.007	
SES_score	933.066	1	933.066	.478	.491	NS
Method of teaching	2807.488	1	2807.488	1.440	.234	**NS**
Error	150162.834	77	1950.167			
Total	973966.000	80				
Corrected Total	154245.950	79				

a. R Squared = .026 (Adjusted R Squared = .001)

The F-test shown in the separate table 4.53 of ANCOVA is computed on the basis of dependent variable (creative thinking score). The type of teaching methods with two levels, flipped classroom and lecture method, are the independent variables. The dependent variable is student's creative thinking scores of private secondary level students and covariate is the socio-economic status.

The analysis of covariance is not significant, F (y, x) (1,77) = 1.44, p=0.234>.05 (see table 4.53). the result explain that who were taught by flipped classroom (M=107.5) and students who were taught by lecture method (M=94.95) have no significant difference (see table 4.51) having controlled for the effect of their socio-economic status (covariate) therefore, the null hypothesis 'There is no significant difference between level of creative thinking (private secondary level students) taught through flipped classroom and that of through lecture method' has been not rejected. This leads to the interpretation that both groups flipped classroom and

lecture method were equally effective in terms of creative thinking of private secondary level students. When their socio-economic status was taken as covariate.

Table 4.54

Leven's test of Homogeneity of Variance for Creative Thinking Score of Secondary Level Private Students

F	df_1	df_2	P	Remark
.232	1	78	.631	**NS**

For the present data the value of (p= 0.631>0.05). hence the assumption of homogeneity of variance is fulfilled.

Table 4.55

Summary of ANCOVA for Effect of Flipped Classroom on Creative Thinking of Secondary Level Private Students When Intelligence is Considered as Covariate.

Source	Type III Sum of Squares	df	Mean Square	F	P	remark
Corrected Model	6769.097[a]	2	3384.549	1.767	.178	
Intercept	28346.578	1	28346.578	14.80	.000	
intelligence	3619.047	1	3619.047	1.890	.173	NS
Method of teaching	3713.547	1	3713.547	1.939	.168	**NS**
Error	147476.853	77	1915.284			

Total	973966.000	80				
Corrected Total	154245.950	79				

a. R Squared = .044 (Adjusted R Squared = .019)

The F-test shown in the separate table 4.55 of ANCOVA is computed on the basis of dependent variable (creative thinking score). The type of teaching methods with two levels, flipped classroom and lecture method, are the independent variables. The dependent variable is student's creative thinking scores of private secondary level students and covariate is the intelligence.

The analysis of covariance is not significant, F (y, x) (1,77) = 1.939, p=0.168>.05 (see table 4.55). the result determined both the group experimental and control were taught respectively flipped classroom (M=107.5) and lecture method (M=94.95) have no significant difference (see table 4.51) having controlled for the effect of their intelligence (covariate) therefore, the null hypothesis 'There is no significant difference between level of creative thinking (private secondary level students) taught through flipped classroom and that of through lecture method' has been not rejected. This leads to the interpretation that both flipped classroom and lecture method had equally effective in terms of creative thinking of private secondary level students. When their intelligence was taken as covariate.

$H_0$10- There is no significant difference between the level of science achievement of secondary level Male students taught through flipped classroom and that of through lecture method.

Table 4.56

Number of the Students of Science Achievement of Secondary Level Male Students According to Teaching Method.

Science Achievement Score	Methods of teaching	No. of Students
	1	55
	2	22

Table 4.56 shows that 55 students were in the control group (labeled group 1) who were taught through lecture method. 22 students were in experimental group (labeled group 2) taught through flipped classroom of secondary level male students.

Table 4.57

Descriptive Statistics for Science Achievement Score of Secondary Level Male Students.

Science Achievement Score	Methods of teaching	Mean	S.D.
	1	33.34	11.92
	2	24.31	10.21

From table- 4.57 the mean score of science achievement of secondary level male students for the group taught through lecture method was 33.34 with standard deviation 11.92. the group taught using flipped classroom had a mean 24.31 with standard deviation 10.21.

Table 4.58

Leven's test of Homogeneity of Variance for Science Achievement Score of Secondary Level Male Students

F	df_1	df_2	p	Remark
2.52	1	75	.116	**NS**

For the present data the value of (p= 0.116>0.05). hence the homogeneity of variance assumption is satisfied.

Table 4.59

Summary of ANCOVA for Effect of Flipped Classroom of Science Achievement of Secondary Level Male Students When Socio-Economic Status is Considered as Covariate.

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	remark
Corrected Model	1501.198[a]	2	750.599	5.756	.005	
Intercept	1417.088	1	1417.088	10.866	.002	
SES score	220.615	1	220.615	1.692	.197	NS
Method of teaching	970.667	1	970.667	7.443	.008	**S**
Error	9650.595	74	130.413			

Total	84037.000	77				
Corrected Total	11151.792	76				

a. R Squared = .135 (Adjusted R Squared = .111)

The F-test shown in the separate table 4.59 of ANCOVA is computed on the basis of dependent variable (science achievement). The type of teaching methods with two levels, flipped classroom and lecture method, are the independent variables. The dependent variable is student's science achievement scores of secondary level male students and covariate is the socio-economic status.

The analysis of covariance is significant, F (y, x) (1,74) = 7.443, p=0.008<.05 (see table 4.59). the result express that there is significant difference between students of flipped classroom (M=24.318) and students of lecture method (M=33.14) (see table 4.57) having controlled for the effect of their socio-economic status (covariate) therefore, the null hypothesis 'There is no significant difference between level of science achievement (secondary level male students) taught through flipped classroom and that of through lecture method' has been rejected. This leads to the interpretation that both flipped classroom and lecture method were equivalently effective with reference to science achievement of secondary level male students. When their socio-economic status was taken as covariate. Lecture method has more effect on science achievement secondary level male students than compare to flipped classroom.

Table 4.60

Leven's test of Homogeneity of Variance for Science Achievement Score of Secondary Level Male Students

F	df_1	df_2	p	Sign
1.495	1	75	.225	NS

For the present data the value of (p= 0.225>0.05). hence the homogeneity of variance assumption is met.

Table 4.61

Summary of ANCOVA for Effect of Flipped Classroom of Science Achievement of Secondary Level Male Students When Intelligence is Considered as Covariate.

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	remark
Corrected Model	1553.425[a]	2	776.712	5.988	.004	
Intercept	2791.684	1	2791.684	21.523	.000	
intelligence	272.842	1	272.842	2.104	.151	NS
Method of teaching	821.250	1	821.250	6.332	.014	**S**
Error	9598.367	74	129.708			
Total	84037.000	77				
Corrected Total	11151.792	76				

a. R Squared = .139 (Adjusted R Squared = .116)

The F-test shown in the separate table 4.61 of ANCOVA is computed on the basis of dependent variable (science achievement). The type of teaching methods with two levels, flipped classroom and lecture method, are the independent variables. The dependent variable is student's science achievement scores of secondary level male students and covariate is the intelligence.

The analysis of covariance is significant, F (y, x) (1,74) = 6.332, p=0.014<.05 (see table 4.61). the result explains there is significant difference between students, who were taught by flipped classroom (M=24.31) and those who were taught by lecture method (M=33.14) (see table 4.57) having controlled for the effect of their intelligence (covariate) therefore, the null hypothesis 'There is no significant difference between level of science achievement (secondary level male students) taught through flipped classroom and that of through lecture method' has been rejected. This leads to the interpretation that both flipped classroom and lecture method had equally effective with regard to science achievement of secondary level male students. When their intelligence was taken as covariate. So, lecture method more effect on science achievement (secondary level male students) in comparison to flipped classroom.

Finding of hypothesis 10 is due to the strong interaction between the type of school (government and private) on science achievement of secondary level male students.

Table 4.62

Interaction Effect of Science Achievement of Secondary Level Male Students.

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Remark
Corrected Model	5196.955[a]	7	742.422	7.811	.000	
Intercept	2447.880	1	2447.880	25.755	.000	
Intelligence	181.264	1	181.264	1.907	.169	NS
SES score	40.902	1	40.902	.430	.513	NS
Method of teaching	.919	1	.919	.010	.922	NS
TypeofSchool	2473.031	1	2473.031	26.019	.000	S
Gender	160.936	1	160.936	1.693	.195	NS
Method_of_teaching * TypeofSchool	.000	0	.	.	.	
Method_of_teaching * Gender	17.519	1	17.519	.184	.668	NS
TypeofSchool * Gender	.000	0	.	.	.	
Method_of_teaching * TypeofSchool * Gender	.000	0	.	.	.	
Error	14446.989	152	95.046			
Total	178215.000	160				
Corrected Total	19643.944	159				

a. R Squared = .265 (Adjusted R Squared = .231)

$H_0$11- There is no significant difference between the level of science achievement of secondary level Female students taught through flipped classroom and that of through lecture method.

Table 4.63

Number of the Students of Science Achievement of Secondary Level Female Students According to Methods of Teaching.

Science Achievement Score	Methods of teaching	No. of Students
	1	25
	2	58

According to Table 4.63, 25 students were in the control group (labeled group 1) taught through lecture method. 58 students of experimental group (labeled group 2) who were taught by flipped classroom of secondary level female students.

Table 4.64

Descriptive Statistics for Science Achievement Score of Secondary Level Female Students.

Science Achievement Score	Methods of teaching	Mean	S.D.
	1	27.96	7.71
	2	33.94	10.56

From table- 4.64, the mean of science achievement of secondary level female students for the group taught through lecture method was 27.96 with standard

deviation 7.71 The group taught using flipped classroom had a mean 33.94 with standard deviation 10.56.

Table 4.65

Leven's test of Homogeneity of Variance for Science Achievement Score of Secondary Level Female Students

F	df_1	df_2	P	Sign.
3.284	1	81	.074	**NS**

For the present data the value of (p= 0.074>0.05). according to table 4.65 the homogeneity of variance assumption is satisfied.

Table 4.66

ANCOVA Table for Effect of Flipped Classroom of Science Achievement of Secondary Level Female Students When Socio-Economic Status is Considered as Covariate.

Source	Type III Sum of Squares	df	Mean Square	F	P	Remark
Corrected Model	650.363[a]	2	325.182	3.350	.040	
Intercept	1755.616	1	1755.616	18.085	.000	
SES_score	23.903	1	23.903	.246	.621	NS
Method_of_teaching	596.283	1	596.283	6.143	.015	**S**

Error	7765.902	80	97.074			
Total	94178.000	83				
Corrected Total	8416.265	82				

a. R Squared = .077 (Adjusted R Squared = .054)

The F-test shown in the separate table 4.66 of ANCOVA is computed on the basis of dependent variable (science achievement). The type of teaching methods with two levels, flipped classroom and lecture method, are the independent variables. The dependent variable is student's science achievement scores of secondary level female students and covariate is the socio- economic status.

The analysis of covariance is significant, F (y, x) (1,80) = 6.143, p=0.015<.05 (see table 4.66). the result express that students, who were taught by flipped classroom (M= 33.94) and those who were taught by lecture method (M=27.96) have significant difference (see table 4.64) having controlled for the effect of their socio-economic status (covariate) therefore, the null hypothesis 'There is no significant difference between level of science achievement (secondary level female students) taught through flipped classroom and that of through lecture method' has been rejected. This leads to the interpretation that both flipped classroom and lecture method were significant. Secondary level female students who were taught through flipped classroom had more science achievement in comparison to those who were taught through lecture method. When their socio-economic status was taken as covariate.

Table 4.67

Leven's test of Homogeneity of Variance for Science Achievement Score of Secondary Level Female Students

F	df_1	df_2	P	Sign
4.273	1	81	.042	**NS**

For the present data the value of (p= 0.042<0.05). so, the homogeneity of variance assumption is not fulfilled.

If you have violated the assumptions then a correction is made. So, researcher have done the adjustment as per Jain Superbrain 5.6. As reported the paragraph 5.3.3.3 of (Andy Field) researcher follow the step levene's test.

Table 4.68

Test of Homogeneity of Variance

		Levene Statistic	df1	df2	p	Sign.
Science Achievement	Based on Mean	6.379	1	158	.013	**NS**
	Based on Median	5.930	1	158	.016	NS
	Based on Median and with adjusted df	5.930	1	139.329	.016	NS
	Based on trimmed mean	5.978	1	158	.016	NS

When both the mean (p=.013) and the median (p=.016) significant value is lesser than .05, showing a significant difference between the male and female variances. To find the variance ratio Andy Field's paragraph 5.3.3.3 (output 5.4) was followed. Paragraph 5.3.3.2 explain the Hartley's F_{max}, also called as the variance ratio (Pearson & Hartley, 1954) this variance ratio between the group with the biggest variance with the smallest variance.

Table 4.69

Variances of Male and Female in Terms of Science Achievement

Science Achievement		FEMALE	MALE
N	Valid	83	77
	Missing	0	0
Mean		32.145	30.766
Std. Error of Mean		1.1120	1.3804
Median		31.000	29.000
Mode		31.0	24.0
Std. Deviation		10.1310	12.1134
Variance		102.637	146.734
Skewness		.430	.019
Std. Error of Skewness		.264	.274
Kurtosis		-.098	-.619
Std. Error of Kurtosis		.523	.541
Range		45.0	49.0

Minimum		11.0	6.0
Maximum		56.0	55.0
Percentiles	25	25.000	24.000
	50	31.000	29.000
	75	38.000	41.00

The male variance 146.734 and the female one is 102.637; the variance ratio is therefore, 146.734/102.637= 1.42. Sample size are large we had 77 males and 83 females.

Table 4.70

Summary of ANCOVA for Effect of Flipped Classroom of Science Achievement of Secondary Level Female Students When Intelligence is Considered as Covariate.

Source	Type III Sum of Squares	df	Mean Square	F	P	Remark
Corrected Model	983.236[a]	2	491.618	5.291	.007	
Intercept	3747.044	1	3747.044	40.329	.000	
Intelligence	356.775	1	356.775	3.840	.054	NS
Method of teaching	343.356	1	343.356	3.695	.058	**NS**
Error	7433.029	80	92.913			
Total	94178.000	83				
Corrected Total	8416.265	82				

a. R Squared = .117 (Adjusted R Squared = .095)

The F-test shown in the separate table 4.70 of ANCOVA is computed on the basis of dependent variable (science achievement). The type of teaching methods with two levels, flipped classroom and lecture method, are the independent variables. The dependent variable is student's science achievement scores of secondary level female students and covariate is the intelligence.

The analysis of covariance is significant, F (y, x) (1,80) = 3.6925, p=0.058>.05 (see table 4.70). the result shows that students, who were taught by flipped classroom (M= 33.94) and students who were taught by lecture method (M=27.96) (see table 4.64) had no significantly differ having controlled the effect of their intelligence (covariate) therefore, the null hypothesis 'There is no significant difference between level of science achievement (secondary level female students) taught through flipped classroom and that of through lecture method' has been not rejected. This leads to the interpretation that both flipped classroom and lecture method technique were similarly effective of secondary level female students of both group experimental and control group. When their intelligence was taken as covariate.

$H_0$12- There is no significant difference between the level of scientific attitude of secondary level Male students taught through flipped classroom and that of through lecture method.

Table 4.71

Number of Secondary Level Male Students of Scientific Attitude According to Teaching Method.

Scientific Attitude Score	Methods of teaching	No. of Students
	1	55
	2	22

Table 4.71 shows that 55 students were in the control group (labeled group 1) who were taught through lecture method. 22 students were in experimental group (labeled group 2) those were taught through flipped classroom of secondary level male students.

Table 4.72

Descriptive Statistics for Scientific Attitude Score of Secondary Level Male Students.

Scientific Attitude Score	Methods of teaching	Mean	S.D.
	1	139.2	21.85
	2	148.13	16.54

From table- 4.72, the mean of scientific attitude of secondary level male students for the group taught through lecture method was 139.2 with standard deviation 21.85. The group taught using flipped classroom had a mean 148.13 with standard deviation 16.54.

Table 4.73

Leven's test of Homogeneity of Variance for Scientific Attitude Score of Secondary Level Male Students

F	df_1	df_2	Sign.	Sign

1.843	1	75	.179	**NS**

For the present data the value of (p= 0.179>0.05). hence the homogeneity of variance assumption is met.

Table 4.74

Summary of ANCOVA for Effect of Flipped Classroom of Scientific Attitude of Secondary Level Male Students When Socio-Economic Status is Considered as Covariate.

Source	Type III Sum of Squares	df	Mean Square	F	p	Remark
Corrected Model	3980.096[a]	2	1990.048	5.111	.008	
Intercept	43603.876	1	43603.876	111.982	.000	
SES score	2725.175	1	2725.175	6.999	.010	S
Method of teaching	2204.600	1	2204.600	5.662	.020	**S**
Error	28814.216	74	389.381			
Total	1580031.000	77				
Corrected Total	32794.312	76				

a. R Squared = .121 (Adjusted R Squared = .098)

The F-test shown in the separate table 4.74 of ANCOVA is computed on the basis of dependent variable (scientific attitude). The type of teaching methods with two levels, flipped classroom and lecture method, are the independent variables. The dependent variable is student's scientific attitude scores of secondary level male students and covariate is the socio-economic status.

The analysis of covariance is significant, F (y, x) (1,74) = 5.662, p=0.020<.05 (see table 4.74). the result shows that there is significant difference between students, of flipped classroom (Experimental group) (M=148.13) and students of lecture method (Control group) (M=139.2) (see table 4.72) having controlled the effect of their socio-economic status (covariate) therefore, the null hypothesis 'There is no significant difference between level of scientific attitude (secondary level male students) taught through flipped classroom and that of through lecture method' has been rejected. This leads to the interpretation that both flipped classroom and lecture method output to be significant. The impact of flipped classroom does more effective on scientific attitude of secondary level male students in comparison to lecture method. When their socio- economic status was taken as covariate.

Table 4.75

Leven's test of Homogeneity of Variance for Scientific Attitude Score of Secondary Level Male Students

F	df_1	df_2	Sign.	Remark
1.945	1	75	.167	NS

For the present data the value of (p= 0.147>0.05). hence the homogeneity of variance assumption is satisfied.

Table 4.76

Summary of ANCOVA for Effect of Flipped Classroom of Scientific Attitude of Secondary Level Male Students When Intelligence is Considered as Covariate.

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Remark
Corrected Model	1345.816[a]	2	672.908	1.583	.212	
Intercept	110691.286	1	110691.286	260.463	.000	
Intelligence	90.895	1	90.895	.214	.645	NS
Method of Teaching	1340.754	1	1340.754	3.155	.080	**NS**
Error	31448.496	74	424.980			
Total	1580031.000	77				
Corrected Total	32794.312	76				

a. R Squared = .041 (Adjusted R Squared = .015)

The F-test shown in the separate table 4.76 of ANCOVA is computed on the basis of dependent variable (scientific attitude). The type of teaching methods with two levels, flipped classroom and lecture method, are the independent variables. The dependent variable is student's scientific attitude scores of secondary level male students and covariate is the intelligence.

The analysis of covariance is not significant, F (y, x) (1,74) = 3.155, p=0.08>.05 (see table 4.76). the result revealed that there is no significant difference between

students, of flipped classroom (M=148.13) and students of lecture method (M=139.2) (see table 4.72) having controlled the effect of their intelligence (covariate) therefore, the null hypothesis 'There is no significant difference between level of scientific attitude (secondary level male students) taught through flipped classroom and that of through lecture method' has been not rejected. This leads to the interpretation that both experimental and control group were found to be identically significant in terms of scientific attitude of secondary level male students. When their intelligence was taken as covariate.

$H_0$13- There is no significant difference between the level of scientific attitude of secondary level Female students taught through flipped classroom and that of through lecture method.

Table 4.77

Number of the Students of Scientific Attitude of Secondary Level Female Students According to Teaching method.

Scientific Attitude Score	Methods of teaching	No. of Students
	1	25
	2	58

Table 4.77 shows that 25 students of control group (labeled group 1) who were taught through lecture method. 58 students were in experimental group (labeled group 2) taught through flipped classroom of secondary level female students.

Table 4.78

Descriptive Statistics for Scientific Attitude Score of Secondary Level Female Students.

Scientific	Methods of teaching	Mean	S.D.
Attitude	1	155.24	15.47
Score	2	157.22	13.37

According to table- 4.78, the mean of scientific attitude of secondary level female students for the group taught through lecture method was 155.24 with standard deviation 15.47. The group taught using flipped classroom had a mean 157.22 with standard deviation 13.37.

Table 4.79

Leven's test of Homogeneity of Variance for Scientific Attitude Score of Secondary Level Female Students.

F	df_1	df_2	p	Sign
.253	1	81	.616	**NS**

For the present data the value of (p= 0.616>0.05). hence the homogeneity of variance assumption is satisfied.

Table 4.80

Summary of ANCOVA for Effect of Flipped Classroom of Scientific Attitude of Secondary Level Female Students When Socio-Economic Status is Considered as Covariate.

Source	Type III Sum of Squares	df	Mean Square	F	P	Remark
Corrected Model	199.296[a]	2	99.648	.504	.606	
Intercept	50405.849	1	50405.849	255.153	.000	
SES score	130.520	1	130.520	.661	.419	NS
Method of Teaching	50.635	1	50.635	.256	.614	**NS**
Error	15804.126	80	197.552			
Total	2052148.000	83				
Corrected Total	16003.422	82				

a. R Squared = .012 (Adjusted R Squared = -.012)

The F-test shown in the separate table 4.80 of ANCOVA is computed on the basis of dependent variable (scientific attitude). The type of teaching methods with two levels, flipped classroom and lecture method, are the independent variables. The dependent variable is student's scientific attitude scores of secondary level female students and covariate is the socio-economic status.

The analysis of covariance is not significant, F (y, x) (1,80) = .256, p=0.614>.05 (see table 4.80). the result revealed that there is no significant difference between students of experimental group who were taught by flipped classroom (M=157.22) and students of control group who were taught by lecture method (M=155.24) (see table 4.78) having controlled for the effect of their socio-economic status (covariate) therefore, the null hypothesis 'There is no significant difference between level of scientific attitude (secondary level female students) taught through flipped classroom and that of through lecture method' has been not rejected. This leads to the interpretation that both experimental and control group were found to be similarly significant in terms of scientific attitude of secondary level female students. When their socio-economic status was taken as covariate.

Table 4.81

Leven's test of Homogeneity of Variance for Scientific Attitude Score of Secondary Level Female Students

F	df_1	df_2	p	Sign
.166	1	81	.684	**NS**

For the present data the value of (p= 0.684>0.05). thus, the homogeneity of variance assumption is satisfied.

Table-4.82

Summary of ANCOVA for Effect of Flipped Classroom of Scientific Attitude of Secondary Level Female Students When Intelligence is Considered as Covariate.

Source	Type III Sum of Squares	df	Mean Square	F	P	remark
Corrected Model	73.047[a]	2	36.523	.183	.833	
Intercept	158202.892	1	158202.892	794.472	.000	
intelligence	4.271	1	4.271	.021	.884	NS
Method of Teaching	53.974	1	53.974	.271	.604	**NS**
Error	15930.375	80	199.130			
Total	2052148.000	83				
Corrected Total	16003.422	82				

a. R Squared = .005 (Adjusted R Squared = -.020)

The F-test shown in the separate table 4.82 of ANCOVA is computed on the basis of dependent variable (scientific attitude). The type of teaching methods with two levels, flipped classroom and lecture method, are the independent variables. The dependent variable is student's scientific attitude scores of secondary level female students and covariate is the intelligence.

The analysis of covariance is not significant, F (y, x) (1,80) = .271, p=0.604>.05 (see table 4.82). the result express that there is no significant difference between students of flipped classroom (M=157.22) and students of lecture method (M=155.24) (4.78) having controlled the effect of their intelligence (covariate) therefore, the null hypothesis 'There is no significant difference between level of scientific attitude (secondary level female students) taught through flipped classroom and that of through lecture method' has been not rejected. This leads to

the interpretation that experimental and control group's students had equally significant in terms of scientific attitude of secondary level female students. When their intelligence was taken as covariate.

$H_0$14- There is no significant difference between the level of Creative thinking of secondary level Male students taught through flipped classroom and that of through lecture method.

Table 4.83

Number of the Students of Creative Thinking of Secondary Level Male Students According to Methods of Teaching.

Creative Thinking Score	Methods of teaching	No. of Students
	1	55
	2	22

Table 4.83 shows that secondary level male students of 55 were in the control group (labeled group 1) who taught through lecture method. 22 students were in experimental group (labeled group 2) taught through flipped classroom.

Table 4.84

Descriptive Statistics for Creative Thinking Score of Secondary Level Male Students.

Creative Thinking Score	Methods of teaching	Mean	S.D.
	1	95.49	46.45
	2	71. 95	33.87

According to table- 4.84 that the mean of creative thinking of secondary level male students for the group taught through lecture method was 95.49 with standard deviation 46.45. The group taught using flipped classroom had a mean 71.95 with standard deviation 33.87

Table 4.85

Leven's test of Homogeneity of Variance for Creative Thinking Score of Secondary Level Male Students

F	df_1	df_2	p	Sign
8.313	1	75	.005	**S**

For the present data the value of (p= 0.005<0.05). hence the homogeneity of variance assumption is not fulfilled. When unequal group size there are adjustment and variation ratio are used to correct for violation of this assumption. To calculate the variance ratio Andy Field's paragraph 5.3.3.3 (output 5.4) was followed. Paragraph 5.3.3.2 explain the Hartley's F_{max}, also called the variance ratio (Pearson & Hartley, 1954) the variance ratio between the group with the biggest variance with the smallest variance.

Table 4.86

Variance of Male and Female in Terms of Creative Thinking

Creative thinking		Male	Female
N	Valid	77	83
	Missing	0	0

Mean	88.766	103.867
Std. Error of Mean	5.0520	5.0618
Median	73.000	92.000
Mode	72.0[b]	141.0
Std. Deviation	44.3313	46.1154
Variance	1965.260	2126.629
Skewness	.619	.087
Std. Error of Skewness	.274	.264
Kurtosis	-.711	-1.088
Std. Error of Kurtosis	.541	.523
Range	162.0	166.0
Minimum	19.0	19.0
Maximum	181.0	185.0
Percentiles 25	53.000	67.000
50	73.000	92.000
75	117.500	141.000

The male variance 1965.26 and the female one is 2126.63; the variance ratio is therefore, 2126.63/1965.26= 1.08. Sample size are large we had 77 males and 83 females.

Table 4.87

Summary of ANCOVA for Effect of Flipped Classroom of Creative Thinking of Secondary Level Male Students When Socio-Economic Status is Considered as Covariate.

Source	Type III Sum of Squares	df	Mean Square	F	P	Remark
Corrected Model	12231.257[a]	2	6115.629	3.300	.042	
Intercept	8740.322	1	8740.322	4.717	.033	
SES score	3526.165	1	3526.165	1.903	.172	NS
Method of Teaching	5815.024	1	5815.024	3.138	.081	**NS**
Error	137128.535	74	1853.088			
Total	756077.000	77				
Corrected Total	149359.792	76				

a. R Squared = .082 (Adjusted R Squared = .057)

The F-test shown in the separate table 4.87 of ANCOVA is computed on the basis of dependent variable (creative thinking). The type of teaching methods with two levels, flipped classroom and lecture method, are the independent variables. The dependent variable is student's creative thinking scores of secondary level male students and covariate is the socio-economic status.

The analysis of covariance is not significant, F (y, x) (1,74) = 3.138, p=0.081>.05 (see table 4.87). the result explains that there is no significant difference between students of flipped classroom (M=71.95) and students of lecture method (M=95.49)

see table (4.84) having controlled for the effect of their socio-economic status (covariate) therefore, the null hypothesis 'There is no significant difference between level of creative thinking (secondary level male students) taught through flipped classroom and that of through lecture method' has been not rejected. This leads to the interpretation that both flipped classroom and lecture method were equally significant in terms of creative thinking of secondary level male students. When their socio- economic status was taken as covariate.

Table 4.88

Leven's test of Homogeneity of Variance for Creative Thinking Score of Secondary Level Male Students

F	df_1	df_2	p	Sign
7.284	1	75	.009	**S**

For the present data the value of ($p= 0.009<0.05$). thus, the homogeneity of variance assumption is not satisfied. See the table 4.85 and 4.86.

Table 4.89

Summary ANCOVA for Effect of Flipped Classroom of Creative Thinking of Secondary Level Male Students When Intelligence is Considered as Covariate.

Source	Type III Sum of Squares	df	Mean Square	F	P	remark

Corrected Model	13273.163[a]	2	6636.582	3.609	.032	
Intercept	18146.778	1	18146.778	9.868	.002	
Intelligence	4568.071	1	4568.071	2.484	.119	NS
Method of Teaching	4476.200	1	4476.200	2.434	.123	**NS**
Error	136086.629	74	1839.009			
Total	756077.000	77				
Corrected Total	149359.792	76				

a. R Squared = .089 (Adjusted R Squared = .064)

The F-test shown in the separate table 4.89 of ANCOVA is computed on the basis of dependent variable (creative thinking). The type of teaching methods with two levels, flipped classroom and lecture method, are the independent variables. The dependent variable is student's creative thinking scores of secondary level male students and covariate is the intelligence.

The analysis of covariance is not significant, F (y, x) (1,74) = 2.434, p=0.123>.05 (see table 4.89). the result express that students, who were taught by flipped classroom (M=71.95) and those who were taught by lecture method (M=95.49) see table (4.84) had no significant difference having controlled the effect of their intelligence (covariate) therefore, the null hypothesis 'There is no significant difference between level of creative thinking (secondary level male students) taught through flipped classroom and that of through lecture method' has been not rejected. This leads to the interpretation that both lecture method and flipped

classroom were found to be equally significant in terms of creative thinking of secondary level male students. When their intelligence was taken as covariate.

$H_0$15There is no significant difference between the level of Creative thinking of secondary level Female students taught through flipped classroom and that of through lecture method.

Table 4.90

Number of the Students of Creative Thinking of Secondary Level Female Students According to Methods of Teaching.

Creative Thinking Score	Methods of teaching	No. of Students
	1	25
	2	58

Table 4.90 shows that, secondary level female students of control group (labeled group 1) contained 25 who were instructed by lecture method. 58 students were in experimental group (labeled group 2) instructed through flipped classroom.

Table 4.91

Descriptive Statistics for Creative Thinking Score of Secondary Level Female Students.

Creative Thinking Score	Methods of teaching	Mean	S.D.
	1	96.44	45.90
	2	107.07	46.23

From the table- 4.91, the mean of creative thinking of secondary level female students for the group taught through lecture method was 96.44 with standard deviation 45.90. The group taught using flipped classroom had a mean 107.07 with standard deviation 46.23.

Table 4.92

Leven's test of Homogeneity of Variance for Creative Thinking Score of Secondary Level Female Students.

F	df_1	df_2	P	Sign
.005	1	81	.943	**NS**

For the present data the value of (p= 0.943>0.05). hence the assumption of homogeneity of variance is fulfilled.

Table 4.93

Summary of ANCOVA for Effect of Flipped Classroom of Creative Thinking of Secondary Level Female Students When Socio-Economic Status is Considered as Covariate.

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Remark
Corrected Model	11692.248[a]	2	5846.124	2.875	.062	

Intercept	3201.396	1	3201.396	1.574	.213	
SES score	9718.590	1	9718.590	4.779	.032	S
Method of teaching	1183.480	1	1183.480	.582	.448	**NS**
Error	162691.295	80	2033.641			
Total	1069825.000	83				
Corrected Total	174383.542	82				

a. R Squared = .067 (Adjusted R Squared = .044)

The F-test shown in the separate table 4.93 of ANCOVA is computed on the basis of dependent variable (Creative thinking). The type of teaching methods with two levels, flipped classroom and lecture method, are the independent variables. The dependent variable is student's creative thinking scores of secondary level female students and covariate is the socio-economic status.

The analysis of covariance is not significant, F (y, x) (1,80) = .582, p=0.448>.05 (see table 4.93). the result shows that there is no significant difference between students, who were taught by flipped classroom (M=107.07) and students who were taught by lecture method (M=96.44) (see table 4.91) having controlled for the effect of their socio-economic status (covariate) therefore, the null hypothesis 'There is no significant difference between level of creative thinking (secondary level female students) taught through flipped classroom and that of through lecture method' has been not rejected. This leads to the interpretation that both flipped classroom and lecture method were found to be equally significant in terms of creative thinking of

secondary level female students. When their socio-economic status was taken as covariate.

Table 4.94

Leven's test of Homogeneity of Variance for Creative Thinking Score of Secondary Level Female Students.

F	df_1	df_2	p	Sign.
.007	1	81	.935	**NS**

For the present data the value of (p= 0.935>0.05). hence the homogeneity of variance assumption is fulfilled.

Table 4.95

Summary of ANCOVA for Effect of Flipped Classroom of Creative Thinking of Secondary Level Female Students When Intelligence is Considered as Covariate.

Source	Type III Sum of Squares	df	Mean Square	F	p	remark
Corrected Model	18354.297[a]	2	9177.149	4.705	.012	
Intercept	19179.630	1	19179.630	9.834	.002	
Intelligence	16380.639	1	16380.639	8.399	.005	S

Method of teaching	32.363	1	32.363	.017	.898	**NS**
Error	156029.245	80	1950.366			
Total	1069825.000	83				
Corrected Total	174383.542	82				

a. R Squared = .105 (Adjusted R Squared = .083)

The F-test shown in the separate table 4.95 of ANCOVA is computed on the basis of dependent variable (Creative thinking). The type of teaching methods with two levels, flipped classroom and lecture method, are the independent variables. The dependent variable is student's creative thinking scores of secondary level female students and covariate is the intelligence.

The analysis of covariance is not significant, F (y, x) (1,80) = .017, p=0.898>.05 (see table 4.95). the result describes that there is no significant difference between students, who taught by flipped classroom (M=107.07) and students who taught by lecture method (M=96.44) (see table 4.91) having controlled for the effect of their intelligence (covariate) therefore, the null hypothesis 'There is no significant difference between level of creative thinking (secondary level female students) taught through flipped classroom and that of through lecture method' has been not rejected. This leads to the interpretation that both flipped classroom and lecture method were equally significant in terms of creative thinking of secondary level female students. When their intelligence was taken as covariate.

A COMPARATIVE STUDY OF FLIPPED CLASSROOM AND LECTURE METHOD ON PERFORMANCE OF SCIENCE STUDENTS AT SECONDARY LEVEL

THESIS

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Chapter – 5

Summary, Findings and Conclusion

Chapter-5

SUMMARY, FINDINGS AND CONCLUSIONS

The summary of the study and its important findings were introduced in this chapter. Thereafter, a conclusion based on the data was inference and hypothesized. Educational implications of this study are mandatory to pen the last chapter because it explains the practice of this research in the educational field. Finally, the suggestions for further research are related to the limitations of the study needs to be taken down to which types of variables are included and excluded in the present study. Researcher suggests this type of study can be done in the future in different ways.

5.1 Summary

Only educators and teachers can stop the downward spiral of the educational system by moving the emphasis from the curriculum pacing guide to the learning demands of the students as they receive instruction. Challenges of the global world demand wide access and improved quality of school education. It cannot be met without using modern and proper teaching methods in the teaching-learning process in a school setting. Using innovative and best teaching methods to educate our future citizens to make a more successful and good citizens. The national education policy for 2019 emphasizes online education as a substitute for traditional teacher-student engagement in the classroom. The focus is on the educational environment. Education is an instrument of social change and it needs to be remolded to understand the rapid scientific advancement. Government makes many educational policies and programs to train the teacher and trained different methods of teaching

according to subject content. A significant turning point in the history of science education was the founding of the royal society in 1664. Numerous scientific academies were founded in the 17th century. Science became more accessible to the average person during the industrial revolution in the 18th century. The evolution of the human species might be considered the beginning of science history. Considering the significance of science, in the All-India Seminar on Teaching Science, held in 1956 at Tara Devi, nearly every facet of science education in schools was discussed. “It offered a unique, uniform approach to teaching science that was suited to the needs and resources of the entire country”. Science and scientific research were given additional attention in the National Scientific Policy Resolution of 1958. Since secondary education is crucial, the National Policy of Education (2019) has expanded the grade level of the right to education up to grade 12 and ensured 100% Gross Enrollment from Pre-School to Secondary Levels by 2030. In the 21st century, science becomes an immense part of our life. At this time, it is the need of our society to develop the field of science & technology. Our government, policies & scheme related to education should focus on science education & teaching. According to the Education Commission (1964–1966), "in a world founded on science and technology, education determines the level of wealth, welfare, and security of the people." Science helps us to understand motion, the evolution of life, chemical constituent, human physiology, plant physiology, etc. Biology theory cannot contradict chemistry, physics cannot contradict biology, and physics not contradict chemistry. The main target of science education is to enhance the understanding of students, construct scientific knowledge, expand scientific literacy and make them answerable citizens. Students earn science

education from school or colleges and despite these various workshops, online lectures, and camps are available to develop the cognitive skills and problem-solving abilities of students. According to the National Curriculum Framework (NCF) 2005, teaching science involves teaching students the concepts, theories, and applications of science appropriate to their cognitive stage. Working on locally significant projects integrating science and technology as well as using systematic experimentation as a technique to find or test theoretical ideas are major components of the secondary stage curriculum. Additionally, it implies that the school needs to include modern libraries, labs, and educational technology laboratories. Curriculum requirements must include constructive learning. Students actively create their knowledge by relating new concepts to established ones using the activities that are provided to them. Under the leadership of Shri. Lal Bahadur Shastri, the Indian Parliamentary and Scientific Committee was established in 1961 and began studying science education in schools the relationship between federal and state policies and decisions and the curricula offered in educational institutions. A deeper comprehension of the nature of science, the growth of skills and a scientific attitude, training in the scientific method, problem-sensing, the development of interest and appreciation, assisting students in better integrating into society, and assisting students in developing suitable career interests are just a few of the many goals of science education in schools. According to researcher at the school level the general objective of science teaching should develop the scientific attitude, reasoning ability, logical thinking, problem-solving ability, etc. in students.

Scientific attitude- "Ideas, values, and perceptions are only a few examples of psychological factors that have an impact on someone's attitude. A person's

attitude is complicatedly influenced by all of these factors" (Maio & Olson 1998). In psychology, an attitude is a mental and emotional phenomenon that resides in or defines an individual. It is intricate and learned via practice. It is a state of mind, how we react, what is our perception regarding the value, and what is our receptive expression against a person, place, things, events, activities, ideas, and traditions. Attitude is based on our feelings, and emotions It can be positive or negative.

Science Achievement- Science achievement means students have sound knowledge of science, better scientific skills, good performance in science subjects, and sophisticated marks in science according to their class level. In this study science achievement refers to the score of the science (Biology) achievement test which is taught by researcher during their experiment.

Creativity- Creativity is the creation of an idea or aim that is both advanced and useful. Creativity is an innovative plan that has value in solving a problem or something modern or advantageous. Global creativity exists. Each of us has some degree of creative ability. The capacity to come up with novel, appealing and practical thoughts or ideas is referred to as creativity. Your ability to think creatively will help you generate unique and uncommon ideas.

UNESCO planning mission (1963) most important mission of all its mission is "Provide all people with access to high-quality education, promote lifelong learning, and mobilize scientific knowledge and policy for sustainable development." These reports provided an overview of the state of science and math education in India and included recommendations for improvement, which means it is a nerve center of teaching. According to the National Science Teachers Association, “the science education community should support 21st-

century abilities in accordance with best practices throughout a science education system, including curriculum, pedagogy, science teacher training, and teacher professional development (NSTA)". The **National Science Education Standards** (1996) were created to lead our country toward a society that values scientific literacy. It assesses the quality of science instruction, science programs that give children the chance to learn science, science support systems for teachers and programs, and the quality of assessment techniques and policies. The immense scope of science is taught by various methods according to age level, grade level, and nature of the content. such as the lecture-cum-demonstration method, the heuristic method, the discussion method, the experimental method, the project method, the laboratory method, the cooperative learning method, and so forth. The lecture method is a teacher-centered and traditional method. It is an oral presentation, the teacher talks and explains facts, principles and wishes the students to understand, listen and take notes. A lecture, in the words of Bligh (1972), "Lecture is a teacher's more-or-less unbroken speech". "A lecture is a didactic educational style, including one-way communication from the active presenter to the more or less passive listener," according to Percival and Ellington (1988). The lecturer creates interest, promotes activity, develops critical thinking, and stimulates or motivates the students through verbal message. In the lecture approach, the teacher supports the oral technique with maps, charts, or other visual aids, but only with a minimal amount of class participation. The lecture approach teaches students in two ways: first, through the lecturer's material presentation, and second, through their information processing and reorganization. Therefore, the amount of information that is delivered, received, and processed by the learner

determines how much is learned and understood using the lecture technique. Although the paper did not explicitly call for the use of "flipping" classrooms, researcher Alison King first proposed the concept in 1993 in her article for flipped classroom "From sage on the stage to guide on the side." It made advantage of class time to impart knowledge and purpose to students. For this claim, King's work is frequent. The term "flipped learning" first into common usage in the early to mid-2000s, thanks to chemistry teachers Jon Bergman and Aaron Sams (Bergman & Sams 2012). renowned works in The New York Times (Fitzpatrick, 2012), the Chronicle of Higher Education (Berrett, 2012), and science (Mazur, 2009); Essentially, "Flipping the classroom" refers to the practice of exposing students to new material outside of the classroom, usually through reading relevant texts or viewing films, and then putting great effort into assimilation during class, maybe through problem-solving, discussion, debates, etc. Barbara Walvoord and Virginia Johnson Anderson promoted the use of this practice in their book Effective Grading (1998). They propose a learning strategy in which students gain firsthand knowledge prior to class and focus on the processing (synthesizing, analyzing, problem-solving, etc.) aspect of learning in class. A "pedagogical approach where direct instruction shifts from the group learning space to the individual learning space, and the resulting group space is transformed into a dynamic, interactive learning environment where the guides students as they apply concepts and engage creatively in the subject matter" is known as the "flipped classroom" (the Flipped Learning Network 2014).

5.1.1Knowledge Gap

Various related studies were reviewed. It was observed that there exist a wide variety of teaching method in the flipped classroom and respective studies were conducted. Flipped classroom was examined with different courses, computer applications, calculus course, STEM (Science, technology, engineering, mathematics) course, effect on students learning, English language learners, traditional classroom, instructional technology, and material development, at different school levels (primary, secondary, high schools and colleges), different subjects (history, math, science, language learning), problem-solving activities, E-book- based flipped learning, khan academy and mathematics software, academic achievement, learner motivation, self-efficacy, oral performance, student's satisfaction, learning achievement, self-regulated learning skills, academic performance, learning attitude, participation level, student perception, gender and age. The finding of these studies shows respective variances. There were very few numbers of studies that compared the lecture method and flipped classroom with science achievement, scientific attitude and creative thinking of both government and private schools. Though, the review revealed differences and similarities in different instances. It was observed that in the flipped classroom there are very insufficient numbers of studies conducted in the Indian context (especially in Bihar) at the secondary level. however, a substantial number of studies were conducted in abroad focusing on the flipped classroom of school students. Even now comparative studies focusing on flipped classrooms for science teaching of secondary level students of two types of school's government and private were hardly found. There was enough evidence of a knowledge gap regarding school education

concerning these variables and covariables. Most of the studies were designed with one type of school either government or private. If there were some studies taken both types of school government and private, though paired methods of teaching flipped classroom and lecture method was not target.

This study in the field of school education both government and private schools is of high significance. Its finding would contribute fresh insight to enhance the quality of school education, increase the student-centered approach, and learn at their own pace. The present study will bridge the knowledge gap in the ongoing trend of research. It enables teachers to overcome with the dilemmatic perception of science teaching, anxiety, and fear of science education from the student's mind. Stakeholders will know about the problem of pedagogy of science teaching which is run in school. Will know the facts of flipped classroom and lecture method and its prose and cones. It will help the teacher by training them with new methods of teaching and update them with new concepts emerging in the teaching-learning process.

5.1.2 Rationale for the Study

For the betterment of science teaching, much research has been done in the field of pedagogy of science. Our government, national policies and schemes related to education from the beginning to till now are continuing to work for the development of science education, and methods of science teaching. Kothari Commission (1964-1966) advised that during the first ten years of schooling, all pupils should get regular instruction in science and mathematics as part of their general education. The teaching approach has been strengthened, and the necessary resources are offered for the subject's instruction. The condition of

government schools in Bihar is not hidden from anyone and as far as private schools are concerned, the teaching work there is somewhat better than that of government schools. But still not the way it should be. In such situation, students are far away from quality education. To do this, researchers should carry out the appropriate kind of studies in a way that reveals the actual state of teaching and learning in classrooms and introduces teaching strategies that enhance or have the potential to enhance student performance. Such type of study found in my review namely the Hoshangabad Science Training Project (HSTP) (1972) was the very first program which was started in 1972 by Kishore Bharat & friends Rural Centre, HSTP focused on improving science education from class 6 to 8. It involves learning by discovery through activities & from the environment. It emphasizes the process of science promoting scientific temper & making the child a confident lifelong self-learner and creator of knowledge. There are very few studies found in India regarding flipped classrooms and its effect, especially in science teaching. In United State there is National Science Education Standards (1996), This program examines the standards for science instruction and places a strong emphasis on the idea that learning processes have a big impact on what students learn. It has some significant implications in terms of learning material and methods. There are various studies related to school education, quality education, and methods of teaching are prevalent in schools. There is a need-to-know what type of learning materials and methods are more effective in science teaching & how we use them to bring a great revolution in science teaching. According to the Times of India report released by NITI Aayog, Bihar ranks second last in the School Education Quality Index. In 2016-17, according to NITI Aayog data, Bihar

recorded a very modest growth of 7.3%. In terms of infrastructure and other facilities, Bihar is second position. The learning outcome of Bihar is 41%. Education Minister Krishna Nandan Parsad Verma said that the state has made a big change in the field of education in 5 years. The special focus of the state is to provide quality education to the students. He further said that we are focusing on many other parameters like teacher quality, cleanliness, hygiene, infrastructure, teaching and learning outcomes etc. This shows that the educational standard of Bihar is far behind compared to other states. In such a situation, there is a need to focus on education and especially science education. From the infrastructure to the quality of teachers, there is a need to look. What kind of teaching method is being used in teaching. It needs to be modernized. There are many new methods in trends so we also need to see who performs better in these modern and new methods. Therefore, the researcher conducted a comparative study of the very traditional method of teaching but today also used in schools the lecture method and the flipped classroom, which is a very new concept, on the science performance of secondary level students. It is anticipated that the study would show that student-centered strategies are superior to teacher-centered ones. It will identify the real and logical effectiveness of flipped classrooms and teaching learning material on science performance. There is a lack of records of empirical evidence related to flipped classrooms used in pedagogical practices especially secondary level in general, while in particular teaching of science needs to be focused on this regard. Some certain reasons and situations prompted the researcher to select the area to study. The proposed study will give logical evidence of the gap between lecture and flipped classrooms. The findings of the study will realize the problem and utility

of the lecture method in science teaching at the school level. Results of the study will promote science teaching through the use of learning material and students learning at their own pace.

The study pursues the following questions: -

I) Does flipped classroom effects science achievement?

ii) Does flipped classroom affect the scientific attitude?

iii) Does flipped classroom affect creative thinking skill?

The providing of the empirical answer to these questions demanded the conduction of an experimental study to determine the impact of flipped classrooms in comparison to lectures on the performance of science students (Science achievement, scientific attitude and creative thinking) at secondary level. To get better insight and empirical evidence of difference between flipped classroom and lecture method.

5.1.3 Title of the Study

The problem under investigation was entitled "A comparative study of flipped classroom and lecture method on performance of science students at secondary level"

5.1.4 Objectives of the Study

The following precise objectives were intended to be attained by the experimental investigation, which was planned and carried out:

1) To compare the effect of flipped classroom and lecture method in terms of science teaching of secondary level students on-
    a) Science Achievement
    b) Scientific Attitude
    c) Creative thinking

2) To compare the effect of flipped classroom and lecture method in terms of science teaching on science achievement of-
    a) Govt. Secondary level students.
    b) Private Secondary level students
3) To compare the effect of flipped classroom and lecture method in terms of science teaching on a scientific attitude of-
    a) Govt. Secondary level students.
    b) Private Secondary level students
4) To compare the effect of flipped classroom and lecture method in terms of science teaching on creative thinking of-
    a) Govt. Secondary level students.
    b) Private Secondary level students
5) To compare the effect of flipped classroom and lecture method on science achievement of-
    a) Secondary level male students
    b) Secondary level female students
6) To compare the effect of flipped classroom and lecture method on a scientific attitude of-
    a) Secondary level male students
    b) Secondary level female students
7) To compare the effect of flipped classroom and lecture method on creative thinking of-
    a) Secondary level male students
    b) Secondary level female students

The hypotheses of the study were: -

5.1.5 Hypothesis of the Study

$H_0$1-There is no significant difference between the science teaching taught through flipped classroom and that of through lecture method on Science Achievement at secondary level students.

$H_0$2- There is no significant difference between the science teaching taught through flipped classroom and that of through lecture method on Scientific Attitude at secondary level students.

$H_0$3- There is no significant difference between the science teaching taught through flipped classroom and that of through lecture method on Creative thinking at secondary level students.

$H_0$4- There is no significant difference between the level of science achievement of Government secondary level students taught through flipped classroom and that of through lecture method.

$H_0$5- There is no significant difference between the level of science achievement of Private secondary level students taught through flipped classroom and that of through lecture method.

$H_0$6- There is no significant difference between the level of scientific attitude of Government secondary level students taught through flipped classroom and that of through lecture method.

$H_0$7- There is no significant difference between the level of scientific attitude of Private secondary level students taught through flipped classroom and that of through lecture method.

$H_0$8- There is no significant difference between the level of Creative thinking of Government secondary level students taught through flipped classroom and that of through lecture method.

$H_0$9- There is no significant difference between the level of Creative thinking of Private secondary level students taught through flipped classroom and that of through lecture method.

$H_0$10- There is no significant difference between the level of science achievement of secondary level Male students taught through flipped classroom and that of through lecture method.

$H_0$11- There is no significant difference between the level of science achievement of secondary level Female students taught through flipped classroom and that of through lecture method.

$H_0$12- There is no significant difference between the level of scientific attitude secondary level Male students taught through flipped classroom and that of through lecture method.

$H_0$13- There is no significant difference between the level of scientific attitude of secondary level Female students taught through flipped classroom and that of through lecture method.

$H_0$14- There is no significant difference between the level of Creative thinking of secondary level Male students taught through flipped classroom and that of through lecture method.

$H_0$15There is no significant difference between the level of Creative thinking of secondary level Female students taught through flipped classroom and that of through lecture method.

5.1.6 Methods of the Study

According to nature of the objectives and as title stated the experimental method was most appropriate. In experimental research considering the type of sampling method and control on subjects' quasi experimental method was found more accurate. So, the researcher used the Quasi experimental (Non-equivalent control group post-test only design) for the present study. Before the treatment pretest was administered as covariates (socio-economic status and intelligence) of both the experimental and control groups. After pre-testing the experimental group was taught through the flipped classroom by sharing the learning material in text and video form. Additionally, the control group received instruction using the lecture style and topic-related display charts. Duration of experiment 38 working sessions and taking 40 minutes of each class.

5.1.7 Sample of the Study

In this study, there is a need for a long duration to experiment, the researcher faced the practical problem to select the schools because after a long time of covid 19 schools were reopened and at that time there was a need to complete the syllabus on time. So, the administrator and principal hesitated to give the class. But researcher ensured that what she will be taught completely under the syllabus. She showed the selected chapters of their lesson and then they were ready to give the class but they warn to maintain the discipline and timetable of school. Convince the principal and headmaster to conduct the experimental

study in their school and the time limit of the researcher was the biggest hurdle. Hence the researcher experimented only in two schools. The present study researcher selected the school's non-probability (conveniently) of both government and private schools. For the government school, the researcher has chosen the B.K.D Zila high school Darbhanga and for private school researcher selected the Salfia school Darbhanga. The sections were randomly assigned to the control and treatment groups. For this study, all those students who are present in the IXth sections of chosen schools are the sample of the study. Hence throughout the experience total 160 students were present in which 80 were the government and 80 were the private school students. In which every school had 40 students were the experimental and 40 were in the control group.

5.1.8 Conduction of Experimental Research

Since the study is experimental, data collection is time taking and it is very important to work in the research process. For that firstly, we selected two schools conveniently one belonged to a private school (Salfia School) and the other was a government school (Zila School). The researcher only selected that school that had at least two sections of the IXth class. The researcher visited the schools and met the students and science teacher of the IXth class. Two sections were randomly selected (fish bowl method) for the treatment and control groups. All the students of Salfia school (private school) had the devices/equipment's which made it possible them for to the flipped classroom. So, there was no need to conduct the demographic profile and then both the sections of Salfia school were randomly selected for treatment and control group. But all the students of Zila school (government school) had no devices

which made it possible for the flipped classroom. So, there was a need to conduct the demographic profile. After getting that researcher separated the students who had such electronic devices/equipment which made it possible for them, for the flipped classroom to be selected for the experimental group. And those who had no such devices/equipment were selected for the control group. Both the experimental and control groups underwent testing for covariate variables (intelligence level and socioeconomic status) before the treatment. Collect the phone numbers of all students and made a WhatsApp group of control and experiment group students. The topics were selected from the IXth class syllabus of Biological Science which was common in both private and government schools. Science (Biology) lessons were taught to the control group using the lecture method, while experimental group were instructed by flipped classroom. The researcher provided the learning materials in text form by hand and videos were provided by WhatsApp, related to selected topics. In a flipped classroom, students had one day to read the texts and see the videos to prepare for the discussions that would take place in class. The next day in the classroom students had given chance to ask their doubts were clear firstly by other students and after that teacher (researcher) was cleared. And second, the next day group discussion was held during class time. In a group discussion, students were arranged sometime even odd roll number wise, sometimes serial wise roll number and sometimes their seating arrangement. The researcher arranged the groups (like Group A, B, C and D) and put one question for one group and gave them 3 minutes to respond and put this same question to all groups. The researcher noted correct responses and marks them accordingly. Similarly, next question was put to the next group and the same process was continued until

each group's turn has not come. All of these processes were carried out until treatment was not completed, meanwhile, the control group received lecture method instruction. After completion of treatment, the researcher conducted test of dependent variables (Scientific Attitude, Science Achievement and creative thinking) and compared the scores of dependent variables of between the groups and also saw the effect of independent variables concerning attribute variables.

5.1.9 Tools Used in the Study

The following tools were used in this study:

(1) Socio- economic status a standardized tool was used by Sunil Kumar Upadhyay and Alka Saxena (Kanpur)

(2) Intelligence level The Group of General mental Ability by S. jalota

(3) Creativity by Baquer Mehdi Verbal creativity test

(4) Scientific Attitude Scale by researcher

(5) Science Achievement test by the researcher.

5.1.10 Data Analysis of the Study

Scores were obtained by all the students of different tools had been carefully collected, coded and analyzed by appropriate statistical techniques. There are different statistical techniques are used in data analysis according to data type and method of the data collecting process. Mean, S.D, Leven's test for homogeneity of variance, skewness and kurtosis for normality, correlation and ANCOVA were used to analyze the data.

5.2 Findings of the Study

Finding-1 (a)

Research question-1 Does the flipped classroom effects science achievement?

Objective No.-1 To compare the effect of flipped classroom and lecture method in terms of science teaching at secondary level students on-

a) Science Achievement

The finding of objective one and research question 1 is both the groups have 160 students 80 in the experimental group were taught through flipped classroom and the other 80 were belongs to the control those were taught through the lecture method. The group taught through the lecture method had a mean score of 31.66 with a standard deviation of 11.026. the group taught using flipped classroom had a mean of 31.30 with a standard deviation of 11.269 having control of the socio- economic status (Covariate). F ratio of data set was respectively. **[$F_{(y, x)}$ (1,157) =.061, p=0.805>.05].** When Intelligence was taken as covariate the F ratio data set were respectively **[$F_{(y, x)}$ (1,157) =.055, p=0.815>.05].**

Interpretation- Results showed that both flipped classroom and lecture method express a similar effect in terms of science achievement of students. When their socio-economic status and intelligence were taken as covariates.

Finding 1 (b)

Research Question- 2 Does the flipped classroom affect the scientific attitude?

Objective no. 1 To compare the effect of flipped classroom and lecture method in terms of science teaching at secondary level students on-

b) Scientific Attitude

The finding expressed that 80 students in the control group were taught by lecture method and 80 students in the experimental group were instructed by flipped classroom. The mean score of scientific attitude for the group taught through the lecture method was 144.21 with a standard deviation of 21.33 and the group who taught by flipped classroom had a mean of 154.725 with a standard deviation of 14.77. control the effect of socio-economic status (Covariate). F ratio data set were respectively **[$F_{(y, x)}$ (1,157) =13.456, p=0.000<.05].** When intelligence was considered as covariate then the F ratio data set were respectively **[$F_{(y, x)}$ (1,157) =13.038, p=0.000<.05].**

Interpretation- The above data revealed that flipped classroom students have a more scientific attitude in comparison to the students taught through the lecture method when their socio-economic status and intelligence were taken as covariate.

Finding 1(c)

Research question- 3 Does the flipped classroom affect creative thinking skill?

Objective- 1 To compare the effect of flipped classroom and lecture method in terms of science teaching at secondary level students on-

c) Creative thinking

The finding of the objective and research question is each group experimental and control group has 80 students taught by flipped classroom and lecture method respectively. The mean score (95.787) of creative thinking for the group taught through flipped classroom had higher with a standard deviation of 45.99. than group taught through lecture method (97.41) with a standard deviation of 45.78. But the analysis portrays creative thinking of flipped classroom and lecture method students has no significant difference at 0.05 level when controlling the effect of socio-economic status, the F ratio data set were **[$F_{(y, x)}$ (1, 157) = .029, p =0.864>.05]** and when intelligence was taken as covariate the F ratio data set were **[$F_{(y, x)}$ (1,157) =.036, p=0.835>.05].**

Interpretation- Results revealed that both flipped classroom and lecture method showed an equal effect in terms of creative thinking of students. When their Socio- economic Status and intelligence were taken as covariates.

Finding- 2 (a)

Objective-2 To compare the effect of flipped classroom and lecture method in terms of science teaching on science achievement of-

a) Govt. Secondary level students.

Findings revealed that at Government Secondary level both the groups experimental and control groups had 40 students in each group. the mean of science achievement of government secondary level students for the group taught through lecture method was 26.40 with a standard deviation 8.68. the group taught using flipped classrooms had a mean of 25.75 with a standard deviation of 9.96. ANCOVA was computed for analyzing the data and the F

ratio of data set were **[F $_{(y, x)}$ (1, 77) = .053, p= 0.819>.05]** when socio- economic status was considered as covariate and when Intelligence was taken as covariate the F ratio data set were **[F $_{(y, x)}$ (1, 77) =.0394, p=0.532>.05].**

Interpretation- The finding showed there was no significant difference between the students who were taught by flipped classroom and that lecture method of science achievement of government secondary level students. When controlling the effect of socio-economic status and intelligence were taken ads (covariates).

Finding- 2 (b)

Objective-2 To compare the effect of flipped classroom and lecture method in terms of science teaching on science achievement of-

(b) private Secondary level students.

The finding of objective 2 (b) explains that both the experimental and control group of private secondary level students had 40 students in each group. The mean science achievement of private secondary level students for the group taught through the lecture method was 36.925 with standard deviation of 10.67. the group taught using flipped classroom had a mean of 36.85 with a standard deviation of 9.73. and having control the effect of socio-economic status (Covariate) the F ratio data set were respectively **[F $_{(y, x)}$ (1, 77) =.000, p=0.984>.05].** When intelligence was taken as covariate the F ratio data set were **[F $_{(y, x)}$ (1, 77) =.003, p=0.953>.05]**.

Interpretation- The result showed that there is the same effect on students' science achievement of private secondary level students, who were taught by

flipped classroom and students who were taught by lecture method having controlled the effect of socio- economic status and intelligence (covariates).

Finding- 3 (a)

Objective- 3 To compare the effect of flipped classroom and lecture method in terms of science teaching on scientific attitude of-

(a) Govt. Secondary level students.

Found that, 40 students were in the control group which was taught by lecture method. 40 students in the experimental group who taught by flipped classroom of private secondary level students. The mean score of scientific attitudes of government socio-economic students for the group taught through the lecture method was 146.725 with a standard deviation of 25.055. the group taught using flipped classroom had a mean of 149.7 with a standard deviation of 15.966. When socio- economic status was taken as covariate then F ratio = **F (y, x) (1,77) = .622, p=0.433>.05.** intelligence as a covariate the F ratio data set were **F (y, x) (1,77) = .423, p=0.517>.05.**

Interpretation- This finding led to that when socio-economic status and intelligence were taken as covariates then the scientific attitude of government secondary level students has the same of both flipped classroom and lecture method.

Finding- 3(b)

Objective-3 To compare the effect of flipped classroom and lecture method in terms of science teaching on scientific attitude of-

(b) private secondary level of students.

The finding expressed that each group had 40 students in the experimental and control group. The mean score of a scientific attitude of private secondary level students for the group taught through the lecture method was 141.7 with a standard deviation of 16.77. the group taught using flipped classroom had a mean of 159.75 with a standard deviation of 11.64. F ratio of data set were **[F $_{(y, x)}$ (1,77) =29.921, p=0.000<.05**] when socio-economic status was taken as covariate and when intelligence was considered as covariate then F ratio of data set were **[F $_{(y, x)}$ (1,77) =31.080, p=0.000<.05].**

Interpretation- The result explained that flipped classroom students has a more scientific attitude than private secondary level students. When their socio-economic status and intelligence were taken as covariates.

Finding- 4 (a)

Objective no- 4 To compare the effect of flipped classroom and lecture method in terms of science teaching on the creative thinking of-

(a) Govt. Secondary level students.

The finding showed that 40 pupils were in the control group and 40 were in the experimental group. The mean score of creative thinking of government secondary level students for the group taught through the lecture method was 96.62 with a standard deviation of 46.26. the group taught using flipped classroom had a mean of 87.32 with a standard deviation of 48.03. Having control the effect of socio-economic status (Covariate) the F ratio data set were **[F $_{(y, x)}$ (1,77) = .608, p = 0.438>.05]** and when controlling the effect of

Intelligence (Covariate) the F ratio data set were **[$F_{(y, x)}$ (1, 77) = 1.839, p=0.179>.05]**

Interpretation- The result expressed that students' creative thinking of government secondary level students, who were taught by flipped classroom and students who were taught by lecture method had no significant difference having controlled the effect of socio-economic status and intelligence (covariates)

Finding- 4 (b)

Objective- 4 To compare the effect of flipped classroom and lecture method in terms of science teaching on creative thinking of-

(b) private Secondary level students.

The descriptive finding reveals that both groups who were taught through the lecture method had 40 students and those who were taught through flipped classroom also had 40 students. The mean score of creative thinking of private secondary level students for the group taught through the lecture method (94.95) was lesser with a standard deviation of 46.30 then the group taught using flipped classroom had a mean (107.5) with a standard deviation of 41.59. Socio-economic status was taken as covariate then F ratio of data set were respectively **[$F_{(y, x)}$ (1,77) = 1.44, p = 0.234>.05]** and controlling the effect of Intelligence (Covariate), the F ratio of data set **[$F_{(y, x)}$ (1, 77) =1.939, p=0.168>.05]**

Interpretation- The result exhibited that there was a twin effect of creative thinking of private secondary level students who taught through flipped

classroom and lecture method having controlled the effect of socio-economic status and intelligence (covariates).

Finding- 5 (a)

Objective- 5 To compare the effect of flipped classroom and lecture methods on science achievement of-

(a) Secondary level male students.

The descriptive finding of objective 5(a) described the 55 students in the control group who were taught by lecture method and 22 students in the experimental group who were taught by a flipped classroom of secondary level male students. The mean of science achievement of secondary level male students for the group taught through the lecture method was 33.34 with a standard deviation of 11.92. the group taught using flipped classroom had a mean 24.31 with a standard deviation 10.21. Controlling the effect of socio-economic status (covariate). **[$F_{(y,\ x)}$ (1, 74) = 7.443, p= 0.0098<.05]** and having controlled the effect of intelligence (covariate). **[$F_{(y,\ x)}$ (1, 74) =6.332, p=0.014<.05].**

Interpretation- It was found that science achievement of secondary level male students who were taught by flipped classroom was less effective in comparison to the lecture method, controlling the effect of socio-economic status and intelligence (covariates).

Finding- 5 (b)

Objective-5 To compare the effect of flipped classroom and lecture method of science achievement of-

(b) Secondary level female students.

Findings expressed that, 25 students were in the control group and 58 pupils were in the experimental group of secondary level female students. The mean score of science achievement of secondary level female students for the group taught through the lecture method was 27.96 with a standard deviation 7.71 The group taught using flipped classroom had a mean 33.94 with standard deviation 10.56. Controlling the effect of socio-economic status (covariate). **[$F_{(y, x)}$ (1, 80) = 6.143, p= 0.015<.05]** and having controlled the effect of intelligence (covariate). **[$F_{(y, x)}$ (1, 80) = 3.692, p=0.058>.05].**

Interpretation- It showed that the experimental group has more effect on science achievement secondary level female students in comparison to the flipped classroom having controlled the effect of socio-economic status and intelligence (covariates).

Finding- 6 (a)

Objective- 6 To compare the effect of flipped classrooms and lecture method on scientific attitude of-

(a) Secondary level male students.

Findings revealed that 55 students in control group taught through the lecture method and 22 students were in the experimental group who taught by a flipped classroom of secondary level male students. The mean score of a scientific attitude of secondary level male students for the group taught through the lecture method was 139.2 with a standard deviation of 21.85. The group taught using

flipped classroom had a mean 148.13 with standard deviation 16.54. F ratio of data set were **$F_{(y, x)}$ (1,74) = 5.662, p = 0.020<.05]** when socio-economic status was considered as covariate. Controlling the effect of intelligence as a covariate the F ratio of data set were **$F_{(y, x)}$ (1, 74) =3.155, p=0.08>.05].**

Interpretation- The result revealed that there is no difference between students' scientific attitude of secondary level male students, who were taught by flipped classroom and students who were taught by lecture method having controlled the effect of socio-economic status and intelligence (covariates).

Finding- 6 (b)

Objective- 6 To compare the effect of flipped classroom and lecture method of the scientific attitude of-

(b) Secondary level female students.

Findings revealed that 25 students were in the control group and 58 pupils were in the experimental group of secondary level female students. The mean score of a scientific attitude of secondary level female students for the group taught through the lecture method was 155.24 with standard deviation 15.47. The group taught using flipped classroom had a mean 157.22 with standard deviation 13.37. Controlling for the effect of their socio-economic status (covariate) F ratio of data set were **[$F_{(y, x)}$ (1,80) = .256, p = 0.614>.05]** and having controlled the effect of intelligence (covariate) the F ratio **[$F_{(y, x)}$ (1, 80) =.271, p=0.604>.05].**

Interpretation- The result revealed that there was a similar effect on scientific attitude of secondary level female students, who were taught by flipped classroom and students who were taught by lecture method having controlled the effect of socio-economic status and intelligence (covariates).

Finding- 7 (a)

Objective- 7 To compare the effect of flipped classroom and lecture method of creative thinking of-

(a) Secondary level male students.

Findings expressed those 55 students in the control group who taught through lecture method and 22 students of the experimental group who taught by a flipped classroom of secondary level male students. The mean score of creative thinking of secondary level male students for the group taught through the lecture method was 95.49 with a standard deviation of 46.45. The group taught using flipped classroom had a mean 71.95 with a standard deviation 33.87. When socio-economic status was taken as covariate the F ratio of data set were **[$F_{(y, x)}$ (1, 74) = 3.138, p= 0.081>.05]** and when controlling the effect of intelligence, then F ratio of data set were respectively **[$F_{(y, x)}$ (1, 74) = 2.434, p=0.123>.05].**

Interpretation- The result showed that there was same effect of creative thinking of secondary level male students, who were taught by flipped classroom and students who taught by lecture method having controlled the effect of socio-economic status and intelligence (covariates).

Finding- 7 (b)

Objective- 7 To compare the effect of flipped classroom and lecture method of creative thinking of-

(b) Secondary level female students.

The finding of descriptive statistics showed that 25 students in control group were taught by lecture method and 58 students of the experimental group were taught through the flipped classroom of secondary level female students. The mean score of creative thinking of secondary level female students for the group taught through the lecture method was 96.44 with a standard deviation of 45.90. The group taught using flipped classroom had a mean of 107.07 with a standard deviation 46.23. When controlling the effect of socio-economic status (covariate) F ratio of data set were **[$F_{(y, x)}$ (1, 80) = .582, p= 0.448>.05]** and having controlled the effect of intelligence (covariate) the F ratio of data set were respectively **[$F_{(y, x)}$ (1, 80) =.017, p=0.898>.05].**

Interpretation- It was found that there was no significant difference between the creative thinking of secondary level female students who were taught by flipped classrooms and that of the lecture method controlling the effect of socio-economic status and intelligence (covariates).

5.3 Conclusions

Conclusions have been drawn according to the results and findings of this study. The conclusion is presented in this section.

- Result showed that there is no significant difference between students, who were taught by flipped classrooms and students who were taught by lecture method having controlled the effect of socio-economic status and intelligence (covariates). It means both flipped classroom and lecture method express a similar effect in terms of science achievement of students.
- It concluded that those students who were taught through flipped classroom had a more scientific attitude in comparison to those students who were taught through the lecture method When their socio-economic status and intelligence were taken as covariates.
- Results concluded that both experimental and control groups were found to be equally effective in the creative thinking of students. When their socio-economic status and intelligence were taken as covariates.
- Furthermore, to check the level of science achievement of government secondary level students taught through flipped classroom and that of through lecture method. After analysis researcher reached the conclusion that there was no significant difference between the students who were taught by flipped classroom and lecture method, controlling the effect of socioeconomic status and intelligence (covariates).
- It also concluded that science achievement of private secondary level students who were taught through flipped classroom and that of through lecture method had a similar effect having controlling the effect of socio-economic status and intelligence (covariates).
- After analysis of objective 3 (a) researcher concluded that students of the flipped classroom (experimental group) and lecture method (Control

group) had the equal scientific attitude to government secondary level students. When their socio-economic status and intelligence were taken as covariates.

- It concluded that private secondary level students who were taught through flipped classrooms had a more scientific attitude in comparison to those students who were taught through the lecture method. When their socio-economic status and intelligence were taken as covariates.
- Creative thinking of government secondary level students had no significant difference between the experimental group who were taught through flipped classroom and the control group who were taught through lecture method. When controlled the effect of socio-economic status and intelligence (covariates).
- Creative thinking of private secondary level students had no significant difference between the experimental and control group when their socio-economic status and intelligence were taken as covariate
- Science achievement of secondary level male students who were taught by flipped classroom was less effective in comparison to those who were taught through lecture method controlling the effect of socio-economic status and intelligence (Covariates).
- Secondary level female students who were taught through flipped classroom had more science achievement in comparison to those who were taught through the lecture method when their socio-economic status was taken as a covariate. When controlling the effect of intelligence, there was no significant difference between the science

achievement of secondary level female students, who were taught by flipped classroom and students who were taught by the lecture method.

- Secondary level males of the experimental group had a more scientific attitude in comparison to the control group. When their socio-economic status was taken as a covariate. When controlling the effect of intelligence (covariate) there was no significant difference between students' scientific attitude of secondary level male students, who were taught by flipped classroom and students who were taught by the lecture method.
- Scientific attitude of secondary level female pupils who taught through flipped classroom had the equal effect of those who were taught through lecture method. When socio-economic status and intelligence were taken as covariates.
- There was no significant difference between the creative thinking of secondary level male students who were taught by flipped classroom and that of through lecture method controlling the impact of socio-economic status and intelligence (covariates).
- There was a parallel effect of creative thinking of secondary level female students, those who were taught by flipped classroom and those who were taught by lecture method having controlled the effect of socio-economic status and intelligence (Covariates).

5.4 Discussion

"The discussion section's objective is to evaluate and assess the study's findings, with a focus on how the findings relate to the study's hypotheses. Start out your

debate by indicating whether or not the study's hypotheses were supported". (R. Burke Johnson and Larry Christensen 2014)

- The result shows that the experimental and the control group have no significant difference in science achievement at secondary level students having controlled for the effect of their socio-economic status and intelligence (covariates) therefore, the null hypothesis 'There is no significant difference between the science teaching taught through flipped classroom and that of through lecture method on science achievement' has been not rejected. It may be possible that after successive confinement of more than one year lockdown of covid 19 all the students were much more engaged in learning at home. Perhaps the lecture method's students were also habituated to studying at home so, the similarity of this effect was diminishing the effect of a flipped classroom. It supports the finding of Cabi Emine (2018).
- The H_o2 There is no significant difference between the level of scientific attitude (secondary level students) taught through flipped classroom and that of through lecture method has been rejected. It may be said that flipped classroom students had a more scientific attitude as compared to lecture method students. When their socio-economic status and intelligence were taken as covariates. This showed that flipped classroom better influenced the process of science. This finding correlated with the study of Jagadesh Besapur (2014), the attitude of science among the experimental group taught through the concept attainment model was found to be higher as compared to the control group of students taught through the traditional method.

- After analyzing the data discussion drawn that the null hypothesis there is no significant difference between the science teaching taught through flipped classroom and that of through lecture method on Creative thinking has been not rejected. And it reveals both experimental and control groups were found to be similarly effective in creative thinking when their socio-economic status and intelligence were taken as covariates. This type of result has not occurred in the review of related literature. The researcher observed during the experiment that the students were active in the early days of the experiment but gradually their motivation decreased. All these reasons may be the cause flipped classroom may not significantly affect on the creative thinking of secondary level students.
- Discussion drawn from the result the null hypothesis there is no significant difference between the level of science achievement of Government secondary level students taught through flipped classroom and that of through lecture method has been not rejected. It means that both flipped classroom and lecture methods were found to be equally effective in terms of science achievement of Government secondary level students. When their socio-economic status and intelligence were taken as covariates. There are many reasons why flipped classroom may failed. Flipped classroom only cannot be responsible, there are several reasons in the researcher's mind, such as - students were not familiar with the flipped classroom, and they will take time to adopt this new method. Teaching materials (text and video) may not have been very effective. It is also possible that the students did not study the text and

did not watch the video at home. Cabi Emine (2018) supports this type of result.

- The fifth null hypothesis- there is no significant difference between the level of science achievement of Private secondary level students taught through flipped classroom and that of through lecture method has been not rejected. It means there was no significant difference between the students who were taught through flipped classroom and those who were taught through the lecture method. When their socio-economic status and intelligence were taken as covariates. It means the type of school did not significantly affect flipped classrooms in terms of science achievement. Cabi Emine (2018) supports this type of result.
- The null hypothesis there is no significant difference between the level of scientific attitude of Government secondary level students taught through flipped classroom and that of through lecture method has been not rejected. It explains that both the experimental and control group were found to be equally effective. When their socio-economic status and intelligence were taken as covariates. It may be the reason that flipped classroom was not effective even in the science achievement of government secondary level students it may also affect the scientific attitude. Anabalagan. S (2020) found in his study that, the attitude toward mathematics has no significant difference between the experimental and control group similar to the result of the present study and support it.
- Conclusion drawn the inference that there was a significant difference between the level of scientific attitude of Private secondary level

students taught through flipped classroom and that of through lecture method has been rejected. It may be said that flipped classroom students had a more scientific attitude as compared to lecture method students. When their socio-economic status and intelligence were taken as covariates. The flipped classroom had succeeded in terms of scientific attitude. Anabalagan. S (2020) also supports this result.

- There was no significant difference between the level of Creative thinking of Government secondary level students taught through flipped classroom and that of through lecture method has been not rejected. It means those students who were taught through flipped classroom had no significant difference from those who were taught through the lecture method. When their socio-economic status and intelligence were taken as covariates. It may be possible that learning materials that were provided and they were instructed that they can use other resource books but students may not do so. They only studied or not those teaching materials which were provided to them. So, it may be the cause when flipped classroom does not affect creative thinking. This kind of finding related to creative thinking did not occur in my review.
- There was no significant difference between the level of Creative thinking of Private secondary level pupils taught through flipped classroom and that of through lecture method has been not rejected. This leads to the interpretation that both flipped classroom and lecture methods were found to be similarly effective in terms of creative thinking of private secondary level students. When their socio-economic status and intelligence were taken as covariates. It observed that students

had not taken much interest to study at home or just watch the video with a cursory glance may be a factor. It may be a factor that, in the question-answer session researcher observed that some students used to ask questions. But their questions were meant to ask about the meaning of terminological words, most of the questions were not have a high level of learning like analysis and application. Very few people were able to give satisfactory answers to the questions asked by the researcher in the group discussion and later the researcher would give their satisfactory answers. It may be caused flipped classroom may not affect creative thinking. Such type of finding related to creative thinking have not occurred in my review

- There is no significant difference between the level of science achievement of secondary level Male students taught through flipped classroom and that of through lecture method has been rejected. It means the students who were taught through the lecture method had more science achievement in comparison to those who were taught through flipped classroom when their socioeconomic status and intelligence were taken as covariate. Discussion about that finding and conclusion contradicts the finding of Hajari. Bharti (2020). This failure of the flipped classroom could be due to a number of reasons, as the researcher observed during the experiment that the male students of the secondary level government school did not show much interest in the flipped classroom, their attendance showed that very few of them came from home to study the learning material (which was in the form of text and video). Because during the study the researcher takes attendance of the

same students in three ways: who is present, who has studied the text, and who has watched the video. It was estimated the interest, motivation and seriousness of students towards flipped classroom which was more prevalent among the students of government school. While in a private school there were two sections of the ninth class, one for girls and the other for boys. Sections were randomly selected and the boy's section has come under the control group and the girls' section was under the treatment group. Thus, there were no boys in the experimental group of the private school, so the lecture method of teaching on science achievement of secondary level male students proved to be more effective.

- There is no significant difference between the level of science achievement of secondary level Female students taught through flipped classroom and that of through lecture method has been rejected. It explains that secondary-level female students who were taught through flipped classroom had more science achievement in comparison to those who were taught through the lecture method. When their socio-economic status was taken as a covariate. Zohagger Yu, Guifang Wang (2016), Anabalagan. S (2020), Hajari. Bharti (2020) and Ligi. B (2020) are supporting this result. But in the case of intelligence taken as a covariate there was no significant difference between the experimental and control group of female secondary level students.
- There is no significant difference between the level of scientific attitude of secondary level Male students taught by flipped classroom and that of through lecture method has been rejected. It means the effect of the

flipped classroom does have more effect on the scientific attitude of secondary level male students in comparison to the lecture method. When their socio-economic status was taken as a covariate. Lokesh T.N (2019) supports a such type of result. But in the case of intelligence taken as a covariate, the null hypothesis 12 has been not rejected. Which showed both groups have an equal effect on scientific attitude. This indicates that the method of teaching was influenced by external variables. Anabalagan. S (2020) supports that type of result.

- There is no significant difference between the level of scientific attitude of secondary level Female students taught through flipped classroom and that of through lecture method has been not rejected. Students of both groups have a similar effect on the scientific attitude of secondary-level female students. When their socio-economic status and intelligence were taken as covariates. It may be possible when the same teacher taught both experimental and control groups. Teacher preparation for flipped classroom reflects on the control group's teaching with the lecture method. Anabalagan. S (2020) supports this kind of result.
- There is no significant difference between the level of Creative thinking of secondary level Male students taught through flipped classroom and that of through lecture method has been not rejected. Both the experimental and control group had a parallel effect on the creative thinking of secondary level male students. When their socio-economic status and intelligence were taken as covariates. It is also possible that the first time they were taught through flipped classroom, the adoption

of this new method may have taken some time to ready to learn at their own pace or they may not mold themselves according to the flipped classroom. The researcher also observed that in the early days, the students seemed to be quite active but gradually they became less motivated. All these factors may matter because the flipped classroom did not affect creative thinking. The study of variable creative thinking in the flipped classroom is not seen in my review.

- There is no significant difference between the level of Creative thinking of secondary level Female students taught through flipped classroom and that of through lecture method has been not rejected. Both groups have an equal effect on the creative thinking of secondary level female students when their socio-economic status and intelligence were taken as covariates. The variable creative thinking with the flipped classroom is not seen in my review.

5.5 Educational Implications of the Findings of the Study

Conclusions have been inferences from the research findings from which some practical implications have been presented in this section.

The flipped classroom has joined a new dimension to the teaching process, which can be enhanced to suit the teacher's qualifications. Better teaching methods make the classroom environment pleasant for both teachers and students. To make flipped classrooms effectively, the teacher as an instructor must develop the student’s ability to learn on their own. Teachers should choose such a teaching process that encourages the students to learn their own, their own time, and according to their intelligence. So that in flipped classroom firstly learning materials are provided to students and instruct them to study this

learning material at home and come to the class so, they can study as much as they want according to their time and their understanding. But it is important for the teacher to motivate the students when they are provided with the learning materials to students. It depends on the teacher's efficiency to motivate the students in the best way for that it develops the enthusiasm for self-learning. In most government schools in India, especially in Bihar, the teacher does not care about the heterogeneity of the classroom. But the flipped classroom allows teachers to have a better understanding of the students. The purpose of education in this modern age is not to be fulfilled by only the transfer of information through the teacher but the only teacher can fulfill the teaching objectives as a guide. The flipped classroom cut out the teacher from the center of the teaching process and put the students in a central place and giving them ample opportunity to change the teacher as a guide and facilitator. The flipped classroom allows the teacher to create learning materials. Teachers can either use the built-in learning materials in the form of text, slides, videos and pictures on the net or create their own. In flipped classrooms learning materials are made up of a variety of sources to teach the same lesson (topic), and it provides various up-to-date information for both teachers and students on the same topic.

- Since the science achievement of government and private secondary level students and secondary level male students cannot be better achieved by flipped classroom. The type of school did not significantly affect science achievement. However, the flipped classroom has other non-cognitive advantages which are only possible through it, for example, learning together, living together, meaning full engagement at home, divergent thinking, consulting with the extra learning material, learning with own pace, and cooperative learning. But in

comparison between males and females who were taught through flipped classroom the female students had more science achievement compare to male students when their socio-economic status and intelligence were taken as covariates. On the other side lecture method, male students had more science achievement than females when their socioeconomic status and intelligence were taken as covariates. So, gender had a significant effect on flipped classroom in terms of science achievement. It was observed by the researcher during the experiment during class time female students were more motivated toward the flipped classroom. They actively participated in group activities and follow the instructions very carefully compare to boys. This result will compel the teacher to more focus on boys' discipline and motivation. Female students had much more ability to adopt this new method compare to boys. Flipped classroom preferably may be used among the girl learners.

- Science achievement of secondary level female students was better achieved by flipped classroom when their socio-economic status was taken as a covariate. But when intelligence was taken as a covariate science achievement was equally achieved by flipped classroom and lecture method. Teachers should focus on the heterogeneity of the classroom in respect of gender, intelligence and socio-economic status of students. In group activity heterogeneity of students should take group should be mixed in nature. School administration should consider the heterogeneity of the students and the classroom when creating the sections. They also ensure the heterogeneity of teachers at the time of new recruitment which is sensitive regarding different types of students.

- Flipped classroom students had a more scientific attitude compared to those students who were taught the lecture method. Government secondary level

students had equal scientific attitudes toward those who taught through flipped classrooms and those who were taught through the lecture method. But the private secondary level students of the experimental group had a more scientific attitude compared to the control group. Scientific attitude can be better achieved by flipped classroom. The type of school had a significant effect on the scientific attitude of secondary level students it means school environment, management and discipline were effects on scientific attitude. So, the policy maker should focus on the school environment, discipline and management. The secondary level male of the experimental group had a more scientific attitude in comparison to the control group but in the case of the secondary level, female students had equally significant who were taught through flipped classroom and that lecture method. Further, in the case of flipped classrooms male and female, females had more scientific attitudes than males. Overall, it may be said that a scientific attitude can be better achieved by flipped classroom. This is a good inclination towards the science realize the objective of scientific attitude flipped classroom may be used, secondary level students. Directive Principles of State Policy, in fundamental duties of part IVA (51A, h) said that to develop the scientific temper. Scientific temper means individuals have an attitude of logical and rational thinking. The Secondary Education Commission's (1952–1953) goals included the development of a scientific mindset that would enable individuals to think clearly and objectively. That makes it an excellent time to start flipping classrooms. Teachers, policymakers and school administration should take action to adopt this new method of teaching. National Council of Educational Research and Training (NCERT, 1961) focuses on science education and developing scientific attitudes in students. So, to fulfill the

objectives of science teaching teachers should use the innovative (Flip Classroom) method in the classroom. To implement the flipped classroom some guidelines should follow by teachers- In the flipped classroom learning materials are given to students before the class, so the teacher should make ensure the language of the learning materials is easy and in accordance with the medium of instruction. Any images included in the text or video should be related to the students' locality. The Video sound should be clear and noiseless. The teacher should prepare the learning materials according to the age, level of psychology and understanding of the students. Special care should be taken that the learning material text and video are in whatever format the students take interested in. The video and text should not be too long which would deprive the student's interest. By what means should the learning material be provided? The teacher should ensure that the material is provided to all the students in a uniform and easy way. After providing the material to the students, the teacher should motivate them in a better way so that they study the given material and then attend class. After providing the learning materials, students should be given time according to the syllabus or according to the time given to complete the chapter so that they can study the material in a better way.

- Male and female secondary students, government and private school students, flipped classroom and lecture style pupils, and secondary level students all benefit equally from creative thinking. But in the other hand female students have more creative compared to male students in the flipped classroom when socio-economic status and intelligence were taken as covariates. Female learner adopts flipped classroom in a better way than the male learner. Preferably flipped classrooms are used for female students. Creative thinking cannot be

better achieved by flipped classroom in the context of the type of school and gender. So, the teacher ensured that the learning materials which were provided to students were attractive and interesting. Teachers should include some puzzles type questions in their learning material. Students should be instructed to take notes of questions that come to their minds during the study and ask the teacher in classroom sessions to answer these questions. Teachers should prepare to answer all the possible questions related to learning materials that have been provided to students. For concept exploration, any group activity should be conducted by the teacher must ensure this will better improve the performance of science teaching (Science achievement, scientific attitude and creative thinking). Teachers should try to involve all the students; the small group should create and give chance to each student to put their views. Teachers should observe them, lead them and most importantly ensure the exploration of concepts in students and satisfy them. Secondary Education Commission (1952-53) aimed that education should provide such type of environment in which the child will be able to creative and constructive activities. School administration should also focus on the school environment, facilities in schools like laboratories, library availability of different resource books, enrich the library and other resources related to the flipped classroom. They should conduct workshops on modern teaching methods and innovative resources of information so that in-service training of teachers can take place. Make the school environment more conducive. School administration should conduct time to time such type of meetings in which teacher can share their experiences with each other and find the solutions to the problem encountered in the teaching strategies used by them. National Council of Teacher Education (NCTE, 1995)

also recommended training the teacher with innovative methods of teaching. Government Policies DIKSHA and NISHTHA are currently running to train the teacher with innovative methods and flipped classroom according to the nature of the content. It also trained the teacher to manage the classroom discipline, engage all students and to take care of the heterogeneity of students in the classroom, this will also help to a teacher to use an effective flipped classroom. Policymakers should also focus on which type of policies are recently run in the teaching-learning process. Check the feasibility of this at the ground level, is the policies implemented in the right way, and whether it is effective or not effective. Policymakers should formulate a policy to adopt a modern teaching method, to conduct a program to update the information of the teacher and which is effective for them. But in spite of all these flipped classrooms can realize the social aim of education and only the basis of cognitive development or science performance we cannot say that flipped classroom was not effective it's much more effective on the non-cognitive development of students.

5.6 Suggestions for Further Study

Besides all these educational implications, the researcher has gained some experience for future research during her research. Research alone cannot cover all aspects of a problem. It is clear that different types of teaching methods have different characteristics and different prose and cones. There are various areas and dimensions of this study that could not be covered in a fixed time and single framework. Based on the experience gained from the current research, the researcher has been able to give some suggestions for further research which are as follows.

- Only government and private school students were included in the study, while other types of schools, such as Navodaya and Kendriya Vidyalaya, could also be included in the research.
- Since flipped classroom did not much effective for cognitive development so more research on their instructional design.
- The study was conducted at the secondary level. It could be conducted at every level of education (primary, higher secondary) and other classes of secondary level.
- In the present study only science performance (science achievement, scientific attitude and creative thinking) was taken while other variables related to the performance of science can be applied like critical thinking, problem-solving ability etc. can be taken and other than science subjects like social sciences, environment, mathematics and languages etc. study can be done.
- The study was conducted in the Darbhanga city of Bihar. However, it can also be done in other districts, cities and villages.
- In this study, the flipped classroom was compared with the lecture method. Flipped classroom can also be compared with other teaching methods.
- The study was conducted at the school level, it can also be seen the effects of flipped classrooms on the college and other programs running in the college.
- The current study was conducted only on regular-mode students and can also be done on distance-mode students.

5.7 Limitations of the Study

- In the present study, only those schools were taken which have two sections of the IXth class and the section was randomly selected. It is possible that the students of different sections are fundamentally different, the researcher was unaware of that, and to bridge this gap, the researcher used the Analysis of Covariance technique to analyze the data and nullify the socio-economic status and intelligence.
- The researcher personally taught both the control and experimental group. It is possible that the researcher's flipped classroom preparation may have had an effect on the control group that was taught by lecture method and it is possible that both groups have no significant difference on performance of science.

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