EFFECTIVENESS OF BLENDED LEARNING STRATEGY ON SCIENCE PEDAGOGY FOR B.Ed. TRAINEES IN TERMS OF ACHIEVEMENT, CRITICAL THINKING AND REACTION

Pre-Presentation Summary

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1.0.0 INTRODUCTION

The present study entitled "Effectiveness of Blended Learning Strategy on Science Pedagogy in terms of Achievement in Science Pedagogy, Critical Thinking and Reaction of B.Ed. Teacher Trainees" is related with the use of Educational Technology and Science Pedagogy. It is experimental in nature. The main aim of the present research is to study the effectiveness of Blended Learning Strategy based on selected concepts of Science Pedagog (Physics & Chemistry) subject for B.Ed. Teacher Trainees of Indore city.

1.1.0 BLENDED LEARNING

Blended Learning is one of the innovative solutions for teaching -learning process in which modern technologies integrated in the teaching and learning process and try to overcome the limitations of the conventional classroom. It is an effective pedagogy and potential to support teaching which enrich the students' learning experience (Harris et al, 2009). Mostly, the institutions are adopting three ways of Blended Learning (i)Access online material through LMS & Traditional instructions (ii) Digital technologies and Conventional teaching (iii) Using Digital technology by the students. (Sharpe,et al. 2006)

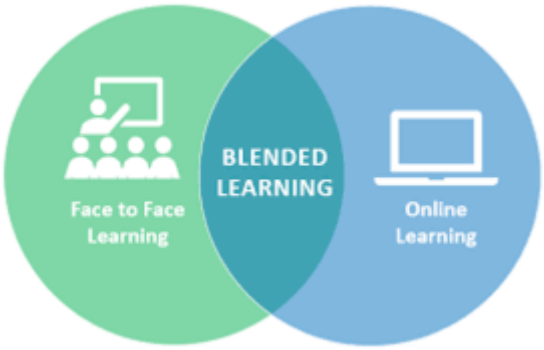

Fig 1.1 Blended Learning

Source: https://www.graniteschools.org/edtech/tip/blended-learning/

Blended learning means that there should be a balance between face-to-face and online learning. It means the combination of classroom learning and online learning without the lack of face-to-face contact. Blended learning is considered a flexible learning strategy because it combines e-learning/digitalised learning with traditional teaching methods. This approach is considered a new teaching strategy for

the relationship between teachers and students. learning experience (Eoghan, 2018). It is some combination of online and face-to-face activities (Online, face-to-face, and blended learning Cramer, 2013). They could create magic within four walls.

Blended learning is a style of learning in which students learn content and instruction through at least some controlled time, space, method, and/or pace and at least some of the tempo. Monitoring the habitat (Horn & Staker, ker, 2012).

1.1.1 Need of Blended learning

- It breaks down the traditional wall of teaching.
- By using it we are able to tailor the learning revel in for every student.
- Mixed studying additionally offers flexible time frames that can be personalized to each person imparting them the ability to analyze at their own pace.
- Enhancement and ultimate transformation of present learning and teaching tactics.
- Enhancement of interaction among students, teachers, peers and the group.

1.1.2 Assumptions of Blended Learning

The key assumptions of a mixed mastering layout given via Garrison and Vaughan (2008) are:

- Thoughtfully integrating face-to-face and on-line learning
- Basically rethinking the design to optimize student engagement
- Restructuring and replacing conventional class contact hours.
- High priority connected to student getting to know and to pedagogical wishes at the same time as thinking about and making use of blended gaining knowledge of processes.
- Strategic and systematic use of generation in affiliation with satisfactory face-to- face surroundings to guide pupil gaining knowledge of.
- Lodging of diversity in scholar mastering studies.
- Mastering that takes region at college students' discretion in phrases of time and location.
- Teacher acts as a facilitator in preference to an expertise transmitter.

1.1.3 Models of Blended Learning Programme

The diagrammatic illustration of six models of combined learning Programme is given in fig 1.2

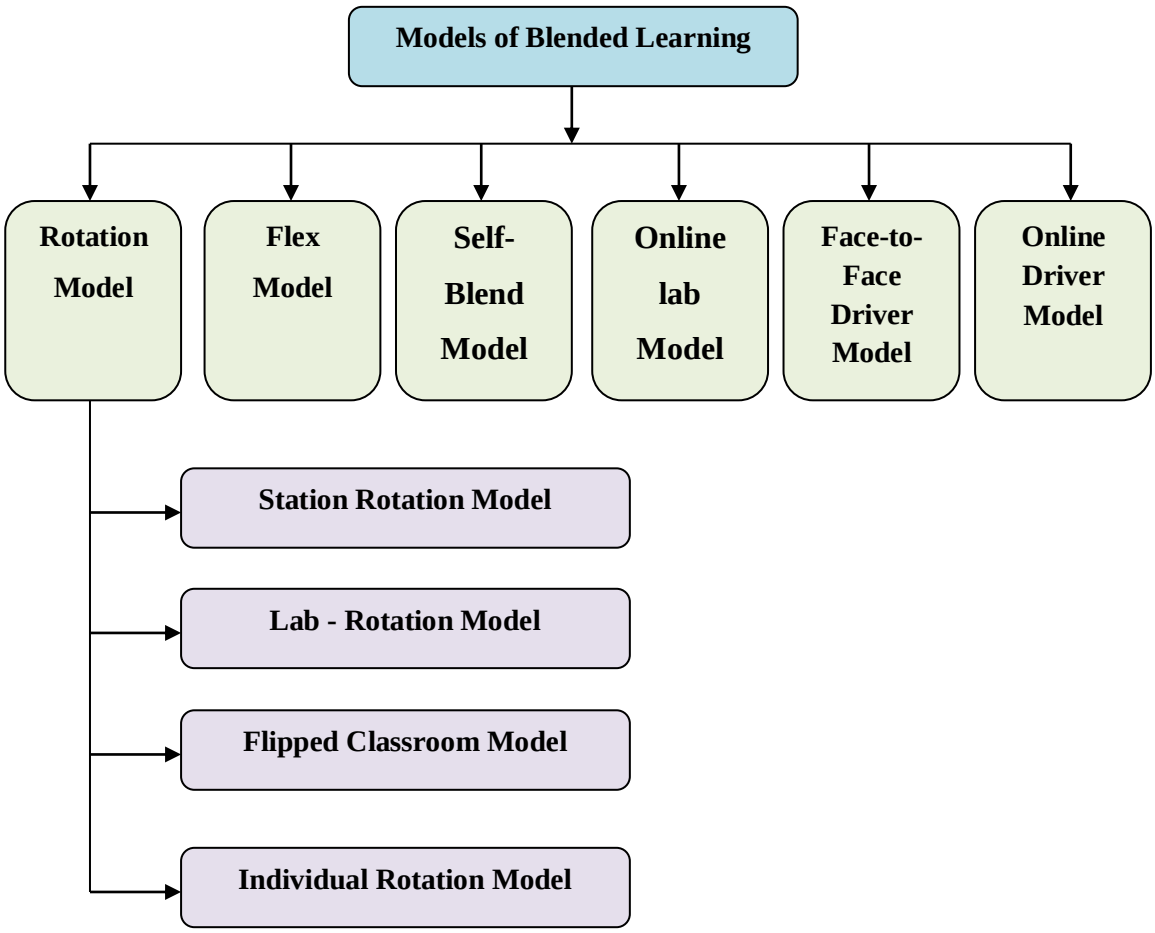

Fig.1.2 Models of Blended Learning

(i) Rotation model

On this form of combined gaining knowledge of, learner rotate between one-of-a-kind stations on a fixed time table both working online or spending face-to-face time with the instructor.

- **Station Rotation Model**

In the Station Rotation Model, students rotate through different learning station on a set schedule within a course or topic. One station involves online learning, while others may include in-person activities like face-to- face instruction,

group work, tutoring, or assessments. This model allows students to experience various learning methods within a single class period.

- **Lab Rotation Model**

The Lab Rotation Model has students move between a computer lab and other learning modalities on a set schedule. In this model, students spend part of their time in a lab for online learning and the rest in a traditional classroom or other settings. The key difference from the Station Rotation Model is that students are not confined to one classroom but move around the campus for different parts of the course.

- **Flipped Classroom Model**

In the Flipped Classroom Model, students learn new content online at home and then practice what they've learned in class. The teacher provides learning materials, including video lectures, Power point presentations, and printed materials. These resources are made available on a website,EduBlog, or shared via WhatsApp. Students review these materials at home, allowing them to absorb the content at their own pace. During class time, students engage in assignments and activities, receiving support from their peers and teacher. This model reverses the traditional classroom setup, enabling students to focus on applying concepts and depending their understanding during class. The main advantage is that students have control over their learning process and can access various resources to suit their learning preferences.

- **Individual Rotation Model**

In the Individual Rotation Model, students follow personalized schedules tailored to their specific needs. They rotate between different learning activities, including at least one online component. The teacher creates individual schedules for each student, allowing them to move through various learning methods at their own pace. Unlike other rotation models, students in this model do not have to go through all the same learning stations. Instead, they focus on the activities that best suit their learning path.

(ii) Flex model

In this model content is basically brought through on-line platform. Instructors provide only help and guidance. It's miles totally self-learning as learner students analyze independently and practice new knowledge in digital environment.

(iii) Self-blend model

This model offers students the possibility to take lessons beyond what's already provided at their group. They must attend conventional lessons and additionally pick to complement their learning via on-line course provided remotely.

(iv) Online lab Model

In on-line lab model path is absolutely designed within the platform and learner must entire their course in ICT lab.

(v) Face-to-face driver model

In face-to-face driver model instructor makes use of distinct techniques of teaching in conventional class room in which learner examine according to their personal pace.

(vi) Online driver model

On this version students work at remote region and content is generally deliver through on-line platform. Learners interact with teacher in online platform if they have doubt.

1.2.0 CRITICAL THINKING

In our everyday life, everybody has to take the decisions in the different field that require reasoning, understanding, interpretation, analysis and synthesis. Critical thinking is the process of analyzing and evaluating thinking with the idea of improving it and taking it to a higher level.

Critical thinking is a mode of thinking about any subject, content or problem in which the thinker improves the quality of his or her thinking by skillfully taking charge of the structures inherent in thinking and imposing intellectual standards upon them (Cascini & Rich, 2007). Good thinking skills will not be developed on their own, they must be taught (Beyer, 1987).

A study conducted by Raths, Jonas, Rothstein and Wassermann in 1967 (as cited in Carr, 1990) and the study conducted by Ennis (1990) suggest that the development of these skills is best done in association with specific content or within domain of knowledge. Therefore the teaching of critical thinking should be integrated into in all courses and in all classroom areas lectures, discussions, homework and writing assignments (Bowers, 2006). Bransford, Vye, Kinzer and Risko (1990) suggested that one way to help students develop critical thinking skills is to focus on problems or cases where they are challenged to deal with real data and experiences. Therefore teachers would benefit the most by having access to discipline specific learning activities that they can seamlessly integrate into their courses.

Paul (1995) defines critical thinking as thinking that displays mastery of intellectual skills and abilities, and disciplined, self-directed thinking that exemplifies the perfections of thinking appropriate to a specific mode or domain of thinking.

In Watson Glaser Critical Thinking Appraisal [WGCTA), critical thinking is defined as a composite of attitudes, knowledge and skills. As per WGCTA, critical thinking is an attitude of inquiry that involves an ability to recognize the existence of problems, knowledge of the nature of valid inferences, abstractions and generalizations in which the weight or accuracy of different kinds of evidences are logically determined and skills in employing and applying the above attitudes and knowledge. Critical thinking is the disciplined mental activity of evaluating arguments or propositions and making judgments that can guide the development of beliefs and taking action (Huitt, 1998).

Burden and Byrd (1994) categorizes critical thinking as a higher-order thinking activity that requires a set of cognitive skills. Having different definitions and meanings for critical thinking, a group of leading researchers with expertise in the field were asked to define critical thinking through a Delphi study to achieve some clarity in the definition of critical thinking (Facione, 1990). The experts envisaged critical thinking as purposeful, self-regulatory judgment that results in interpretation, analysis, evaluation, and inference, as well as explanation of the evidential, conceptual, methodological, criteriological, or contextual considerations upon which that judgment is based. They hypothesized that there are a set of intellectual virtues or habits of mind that reflect one's dispositions to think critically.

From the above mentioned definitions it can be said that in the Critical Thinking Skills analysis , interpretation ,deduction ,reasoning , inference, facts and opinion are included.

1.3.0 RATIONALE OF THE STUDY

The current era is of technology and whole world is going to digitalized. In the realm of education, an educator incorporates a great opportunity to seem at their curriculum in a very broad sense, beyond traditional structures. (Jeffries, 2013). In traditional method teachers are using lecture method incorporate with traditional teaching aid like chart, models etc. but in present scenario students are using digitalized instrument and they attract with these gadgets, therefore there is a need to include digitalization with innovative teaching strategies in education sector for the development of meaningful learning and higher order thinking skills in students. NCF 2005 recommended that technology should be used in such a manner that it can shift the teaching - learning process from teacher centric to learner centric with flexible learning process, but meanwhile some questions arisen viz. how technology can be used in teaching-learning process? can technology replace the teacher? So, to get the answers of these questions researcher reviewed previous researches in the field of Educational Technology. Nowadays Educational technology uses digital mediums to enhance teaching and learning in the classroom and in online environment.

Around 95% of teenagers have a Smartphone, or at least have access to one in their home (Anderson & Jiang, 2018). Smartphone, desktop computers, laptops, tablets and streaming media devices are now commonplace in many families (Pew

Research centre, 2017). Many school/college authorities are pouring money into expanding access to technology, but many teachers are unprepared to use it effectively to promote student learning (Greer et al., 2014; Harasim, 2017, Means et al.2010, 2013) So, the hardest job for teacher is to become more advance not only in content knowledge but also in technology.

Since traditional and online learning approaches continued to evolve, a third mode of teaching evolved as a result of combining the two. As a result, Blended Learning emerged as a method of combining the benefits of variety of theories, technologies and practices (Haijan,2011). Blended learning is the game changer strategy that enables individualization, engagement, and flexibility. It offers a transformative future for education system which bridge the gap between remote and face-to-face learning. Blended learning allows flexibility with the variety of learning modalities in which student can access course content with their own pace and participate in learning activities in the classroom where child centric learning can bepossible. "Blended methods 28 allow professors to vary how they employ class time in order to help students understand information more effectively" (Osgulthorpe & Graham, 2003, p. 231).

In higher education teacher used mostly traditional method of teaching and in this type of teaching-learning process learners behave like passive receptors of knowledge. Demand of present time is that teacher should have to change the teaching strategy in the form of blended mode in which in-campus and off-campus activities included for attainment of lower-level objectives as well as the higher-level objectives. So, the researcher has tried to review previous researches in the field of Blended-Learning. In review of researches, researcher has found a number of studies related to effectiveness of Blended Learning Strategy in terms of various variables.

Various researches such as El-Deghaidy and Nouby (2008), Melton et al. (2009), Bridget Melton and others (2009), Hong and Miao (2009), Vanicharoenchai and Tosulkaew (2010), Yapici and Atlas Akbayin (2012), Gill and Beryar (2014), Almasaeid (2014), Saritepeci and Cakir (2015) , Murray (2017), Oweis (2018) and Harahap, et al. (2019), studied the comparison of Blended Learning with traditional method in terms of Achievement at School and University level and found that student taught through Blended Learning strategy contributed more than the traditional methods, whereas Utami (2018) Compared blended and conventional

teaching and found that Blended Learning group did not achieve statistically significant greater mean scores as compared to traditional learning group.

Saai et. al (2011) studied the effect of Blended e-learning environment in terms of achievement and attitude and found significant difference in gain score in favor of blended e-learning approach. These findings were in collaboration with the findings of Lobez-perez et al. (2011) who found a positive effect of Blended Learning in raising the exam passes rates. Muhammad, Ali and Muhammad (2013) Studied effectiveness of Blended Learning in terms of achievement. Lin, et al. (2016) studied the effectiveness of Blended lLarning in terms of achievement and attitude. Ceylan and Kesici (2017) and Cifici (2020) studied effectiveness of Blended Learning in terms of Achievement and attitude respectively and found Blended-Learning is effective.

Garcia et al. (2015) found that critical thinking skills can be enhanced by the effective use of Blended Leaning. Nusafitri et al. (2020) found that developed Blended Learning model improved Critical Thinking skills. Korkmaz and Karakus (2009) and Dechai et al. (2019 B) also found that Blended Learning Model enhanced the satisfaction level and critical thinking of students. McCarthy (2004) found that relationship exists between academic performance and Critical Thinking dispositions. On the other hand Lee (2004), Bekele and Menchaca (2009) found that experimental and control group both performed equally on Critical Thinking task. Apart from that Akyuz and Samsa (2009) found that Critical Thinking does not improve in Blended Learning environment.

Ali et al. (2013) Khaaisang and Likhitdamrongiat (2015), Al-Quadah et al. (2018) Koraneekij et al. (2019), Law et al (2019), Almasi and Zhu (2020), Bonitasya, et al. (2021), individually investigated the enhancement of students' cognitive presence using Blended Learning and found a significant increase in the cognitive skills of the students, whereas Fitri et al. (2019) was found that there was the influence of Student's Mathematical resilience learning with Blended Learning as well as conventional learning.

In the previous researches, researcher has found that some researches have been conducted related to study the effect of Blended learning on exposure to technology, in this context Khairiyyah et al. (2021), and Sujannah et al. (2020)

studied the effect of Blended Learning using Google classroom in terms of learning and writing ability respectively. Hosseinpour, et al. (2019) and Rina et al. (2021) used Edmodo and found Blended Learning is effective in terms of writing proficiency and learning respectively. Qamar et al. studied about utilization of WhatsApp application as discussion media in Blended Learning and found effective. On the other hand, Shin (2011) integrated face book and peer assessment with Blended Learning in terms of learning English writing and satisfaction and found face book play an important role in it.

In all these reviewed researches, researcher adopted only quantitative research approach. Few of the researcher namely Dragon lilc et al. (2013) and Mukaddes Erden and Pinar Nuhaglu kibar (2014), Almasi and Zhu (2020) have adopted mixed-method approach (quantitative and qualitative both) with respect to effectiveness of Blended Learning in terms of students' perception, self-confidence, opinion and cognitive presence respectively.

From the above-mentioned reviews of researches, it is observed that most of the researches conducted on international level whereas only few researches conducted in Indian Educational context on effectiveness of Blended Learning strategy on science pedagogy at B.Ed. level. Very few researches are conducted on Blended Learning with Achievement and Critical Thinking. Researcher has not found any Mixed-method research (Quantitative andQualitativeboth) work done on Blended Learning Strategy taking Critical Thinking as a dependent variable in Indian context. Therefore researcher wants to fulfill the gap and decide to take this important area. It indicates the need of conducting more researches related to this area. So, the researcher has selected the present title for the research.

1.4.0 STATEMENT OF THE PROBLEM

The problem of the present research study was worded as:

Effectiveness of Blended Learning Strategy on Science Pedagogy in terms of Achievement in Science Pedagogy, Critical Thinking and Reaction of B.Ed. Teacher Trainees

1.4.1 KEY TERMS & OPERATIONAL DEFINITIONS OF VARIABLES

Achievement in Science Pedagogy: It represents a combined measurable outcome of the selected content of four units of prescribed syllabus of DAVV affiliated colleges for Science Pedagogy (Physics and Chemistry Teaching) subject which is assessed through combined Achievement Tests (T- I to T- IV) developed by the researcher.

Critical Thinking : It is referred to various cognitive skills i.e. analogy, fact, opinion, arguments, inference, deduction reasoning, assumption and comparison skill. It is assessed through the composited scores on various skills of the Critical Thinking Skill Test.

Blended Learning Strategy : Blended Learning Strategy is a combination of In-campus (Face-to-Face interaction, Discussions, PS, TPS) and Off-campus (Digitalized Medium, Videos, PPTs, Instructional Materials) Strategy which is used to attain the learning outcome.

Reaction : It represents the quantifiable responses of the B.Ed. Trainees towards the various aspects i.e. Appropriateness of content, related to implementation, Student centered approach, Usability of learningresources used in Blended Learning Strategy on Science Pedagogy in reaction scale.

1.5.0 VARIABLES OF THE STUDY

The researcher considered following independent and dependent variables for the study.

Independent Variables

In present study researcher tries to establish the effectiveness of Blended Learning Strategy on Science Pedagogy in comparison to traditional method of teaching. Therefore, the independent variable was Treatment having two levels namely. Blended Learning Group (Experimental Group) and Non-Blended Learning Group (Experimental Group)

The secondary independent variable was Intelligence having two levels i.e. High and Low intelligence

Dependent Variables

In the present study following were the dependent variable :

i. Achievement in Science Pedagogy

ii. Critical Thinking

iii. Reaction

1.6.0 OBJECTIVES

The objectives of the present study were as follows:

1. To compare the adjusted mean scores of Achievement in Science Pedagogy of Blended Learning group (Experimental group) and Non-Blended Learning group (Control group) by considering Pre-Achievement in Science Pedagogy as a covariate.
2. To study the effect of Treatment, Intelligence and their interaction on Achievement in Science Pedagogy by considering Pre-Achievement in Science Pedagogy as a covariate.
3. To compare the adjusted mean scores of Critical Thinking of Blended Learning group (Experimental group) and Non-Blended Learning group (Control group) by considering Pre-Critical Thinking a covariate.
4. To study the effect of Treatment, Intelligence and their interaction on Critical Thinking by considering Pre-Critical Thinking as a covariate.
5. To study the Reaction of Blended Learning group (Experimenal group) of B.Ed. Trainees towards the treatment in terms of Blended Learning Strategy.
6. To explore the views of B.Ed. Trainees of Blended Learning Group on how the Blended Learning Strategy can be treated as a platform for effective teaching-learning process.

1.7.0 HYPOTHESES

The following were the hypotheses of the present study:

1. There is no significant difference between adjusted mean scores of Achievement in Science Pedagogy of Blended Learning group (Experimental group) and Non-Blended Learning group (Control group) by considering Pre-Achievement in Science Pedagogy as a covariate.

2. There is no significant effect of Treatment, Intelligence and their interaction on Achievement in Science Pedagogy by considering Pre-Achievement in Science Pedagogy as a covariate.

3. There is no significant difference between adjusted mean scores of Critical Thinking of Blended Learning group (Experimental group) and Non-Blended Learning group (Control group) by considering Pre-Critical Thinking as a covariate.

4. These is no significant effect of Treatment, Intelligence and their interaction on Critical Thinking by considering Pre-Critical Thinking as a covariate.

1.8.0 DELIMITATIONS

Following were the delimitations of the present research:

1. The experiment was conducted on six Colleges which are affiliated to DAVV, Indore city only.

2 Blended Learning Strategy was used only on selected content of prescribed syllabus of Science Pedagogy (Physics & Chemistry) subject of second semester for B.Ed. Colleges affiliated to DAVV Indore only.

3. Only Flipped model was used for Blended Learning Strategy.

4. Only Videos, PPTs and learning materials were used for off-campus strategies.

5. In Face-to-face interaction only Discussions, PS and TPS strategies were used.

6. The study comprised of only 232 B.Ed. Trainees.

7. In the present studyonly Intelligence takenas secondaryIndependent variable.

1.9.0 DEVELOPMENT OF BLENDED LEARNING STRATEGY

For the Development of Blended Learning Strategy on Science Pedagogy for B.Ed. Trainees Researcher has used Design of Blended Learning Strategy suggested by Huang and Zhou (2005). They suggested three steps namely, i) Pre-Analysis ii) Activity and Resource Design iii) Instructional Assessment

Stepwise details of developed Blended Learning Strategy for the present research work are as follows :

1. Pre-Analysis Stage

Researcher analyzed and Observed Various Blended Learning Strategies to know that what extent online learning could be blended with face-to-face instructions. Researcher also analyzed the B.Ed. curriculum, B.Ed. trainee's characteristics, Environmental features and Available Resources and Scope for implementation. The main aim of this stage is to lay a sound foundation for organization of Blended Learning Strategy.

2. Activity and Resource Design Stage

At this stage the activities and resources were selected for in-campus (face-to-face) interaction and for off-campus strategy with Digital Media. The course content related to the science pedagogy has been analyzed in detail by the researcher. following topics were selected for the Treatment :

UNIT - I

- Concept of Science - Meaning, definition & Scope
- Nature of Science
- Scientific Attitude - Meaning, Importance and Quality of a person who possesses Scientific Attitude,
- Scientific Method - Meaning, Importance & Steps

UNIT – II

- Bloom's Taxonomy, Instructional Objectives of Teaching Science Pedagogy & Writing them in behavioral terms

UNIT - III

- Approaches Lecture Cum Demonstration, and Methods : Inductive, Deductive, Problem Solving, Enquiry,
- Concept Mapping

UNIT - IV

- Audio-Visual Aids Classification & Selection)
- Lesson Plan formats based on different Approaches and Method
- Unit Plan

On the basis of this analysis and Selection, the content of the course was divided into various parts. In the present Study Flipped model of Blended Learning was used in this model. learning resources like video, PPTs and instructional material were selected and developed for off campus task and format TPS , Discussions and Problem solving method were developed for in campus activities.

3. Instructional Assessment stage

Instructional assessment is the final step of designing Blended Learning Strategy, which is based on the instructional objectives and the activities carried out. It is assessed through analyzing their interaction, examination of content knowledge through tests, participation and face-to-face interaction.

1.10.0 POPULATION AND SAMPLE

The present study was Mixed method in nature. It conducted in two phases i.e. Tool development phase and Experimental phase. The population for this study comprised of B.Ed. Trainees of Teacher Training colleges affiliated to Devi Ahilya Vishwavidyalaya, Indore city.

1.10.1 Phase I: Sample for Tool Construction

The Critical Thinking skill test was developed for the assessment of Critical Thinking skills of B.Ed. Trainees. For the standardization process of tool, the sample was selected in two levels i.e. (i) Preliminary try out (for Item Analysis) and (ii) Establishment of Reliability and Norms.

(i) Preliminary Try out

For Preliminary Try out stage, the sample was selected from seven Teacher Training Colleges which were affiliated to DAVV, Indore city. The sample comprised of 238 B.Ed. Trainees of third Semester batch of session 2020-21 from Annie Besant College, Shri Jain Diwakar College, Shri Vaishnav College of Teacher's Training,

Compfeeders Takniki Prakshishan Sansthan, Oxford International College, VidyaSagar College and Indore International College. The college-wise distribution of sample is given in Table **1.1**.

Table 1.1

College wise distribution of B.Ed. Trainees for Preliminary Tryout

S.No.	Name of College	No. of B.Ed. Trainees
1.	Annie Besant College	38
2.	Shri Jain Diwakar College	31
3.	Shri Vaishnav College of Teachers Training	28
4.	Compfeeders Takniki Prakshistan Sansthan	27
5.	Oxford International College	36
6.	Vidya Sagar College	40
7.	Indore International College	38
	Total	**238**

From the Table 1.1, it is observed that the preliminary draft of the Critical Thinking Skill Test was administered on 238 B.Ed. Trainees of Seven Colleges, out of them, 38 B.Ed. trainees from Annie Besant College, 31 from Shri Jain Diwakar College, 28 from Shri Vaishnav College of Teacher's Training, 27 from Compfeeders Takniki Prakshishan Sansthan, 36 from Oxford College, 40 from Vidya Sagar College and 38 from Indore International College. The B.Ed. trainees belonged to both Hindi and English Medium.

Establishment of Reliability and Norms

At this level, the sample comprised of 276 B.Ed. Trainees of first semester, (2020-21) from seven colleges of Teacher Training of Indore City. All colleges were affiliated to DAVV. The college wise distribution of sample for establishment of reliability and norms is presented in the **Table 1.2**

Table 1.2

College wise Distribution of Sample on Second Level of Too Construction (Establishment of Reliability and Norms)

S.No.	Name of College	No. of B.Ed. Trainees
1.	Annie Besant College	52
2.	Cambridge International College	38
3.	Akshay Academy	36
4.	Compfeeders Takniki Prakshistan Sansthan	35
5.	Arihant College	38
6.	Aspire College	36
7.	Indore International College	41
	Total	**276**

From the table 1.2, it is observed that the sample for the establishment of reliability and norms of the test was comprised of 276 B.Ed. Trainees of seven Colleges namely; Annie Besant College (52), Cambridge International College (82), Akshay Academy (36), Compfeeders Takniki Prakshistan Sansthan (35), Arihant College (38), Aspire College (36), and Indore International College (41).

1.10.2 Phase II: Sample for the Experimentation Phase

In the phase of experimentation, the sample was selected in two stages i.e. Quantitative data stage and Qualitative data stage.

i) Quantitative Data Stage (Experimental Stage):

For the experiment, purposive sampling technique was used. For experimentation B.Ed. trainees of Science Pedagogy of six teacher training colleges namely, Shri Vaishnav College of Teachers Training, Cambridge International, Oxford College, Annie Besant College, Shri Jain Diwakar College and Shri Gujrati College of Education of Indore City were selected. Out of them three colleges were assigned as Experimental Group (Blended Learning Group) and another three colleges were assigned as control Group (Non-Blended Learning Group). The medium of

instruction was Hindi as well as English. The age of B.Ed. Trainees is between 21-35 years. The distribution of the Sample on the basis of treatment is given in table 1.3

Table 1.3

Treatment-wise Distribution of Sample

Treatment	Name of College	No. of Sample
Experimental Group (Blended Learning Group)	Shri Vaishnav College of Teachers Training	31
	Cambridge International College	39
	Oxford International College	35
	Total	**105**
Control Group (Non-Blended Learning Group)	Annie Besant College	42
	Shri Jain Diwakar College	41
	Shri Gujrati Samaj College	44
	Total	**127**
Grand Total Sample		**232**

From the Table 1.3, It is clear that the sample for the Experimental phase comprised of 232 B.Ed. Trainees of Six Colleges of Second Semester of session 2021-22, out of which the Experimental Group comprised of 105 B.Ed. Trainees, namely, Shri Vaishnav College of Teachers Training (31), Cambridge International (39) and Oxford International College (35). The Control Group comprised of 127 B.Ed. Trainees namely, Annie Besant College (42), Shri Jain Diwakar College (41), Shri Gujrati Samaj College (44). The age group of sample was between 21 to 35 years. The medium of instruction of B.Ed. trainees was Hindi as well English. They belonged to average Socio-Economic Status.

ii) Qualitative Data Stage (Post Experimentation)

At this stage, sample was selected from the same experimental group. The sample was selected by using random sampling technique. 15 B.Ed. Trainees were selected from the same experimental group. The main purpose of qualitative research is to strengthen the results obtained by the quantitative analysis of the data regarding effectiveness of Blended Learning Strategy in terms of Achievement in Science Pedagogy and Critical Thinking. The distribution of the sample for qualitative data stage along with participants code is presented in table 1.4

Table 1.4

Distribution of sample of Blended-Learning Group

College Name	Sample for Experiment	Sample for Case Study	Participant code
Shri Vaishnav College of Teachers Training	31	5	#P1 to #P5
Cambridge International	39	5	#P6 to #P10
Oxford International College	35	5	#P11 to #P15
Total	105	15	

It can be seen from table 1.4, Total 105 students have given treatment with Blended Learning Strategies. These students were selected from three colleges, namely, Shri Vaishnav College of Teachers Training, Cambridge International and Oxford International College. For the case study 15 students were selected randomly from Experimental Group (Blended Learning Group).

1.11.0 RESEARCH DESIGN

In the present study, Mixed method research design has been used. This research design is used for enhancing the results obtained in the Quantitative research. In the mixed method research, a number of research designs are available from which researcher has used Sequential Explanatory design. In this design the combined use of quantitative and qualitative research has been used to arrive at convergent findings. For that, first researcher has used Non-equivalent control group design for

quantitative study then Miles-Huberman case study method was used for the qualitative study.

Experimental Design: Non-equivalent control group design

For the Quantitative data collection, experimental study was designed on the basis of non-equivalent control group design. According to Campbell and Stanley (1963) the layout for the research design is as follows:

O X O

…….

O O

Where,

O = Pre-test & Post observations

X = treatment with Developed LMS

\- = treatment with traditional method of teaching

…… = Non-equivalent groups

There were **t**wogroups for the research, one was designed as experimental group and other was designed as control group. Six B.Ed. colleges were selected purposively for treatment. The groups of B.Ed. trainees of three colleges that received treatment through Blended Learning were called as Experimental group, and the groups of B.Ed. trainees of other three colleges that were continuing with traditional method were called as Control group (Non Blended Learning Group)

Qualitative Study: Miles-Huberman Case Study

The researcher has adopted Miles Huberman, (1994) case study method. Firstly, data were collected from 15 randomly selected B.Ed. Trainees from experimental group (Blended Learning group) through a tool having six semi-structured open-ended questions. The organized information which was accessible for the data analysis has been used for drawing relevant conclusions. Conclusions were verified from the data to be tested for their validity by comparing the conclusions from the quantitative data.

The quantitative and qualitative studies are involved in the whole experimentation process which has been presented in a schematic way in table 1.5.

Table 1.5

Schematic Presentation of the Experiment:

Activity	Groups		Duration
	Control	**Experimental**	
Pre-Tests			
Critical Thinking skill test	Administration of Critical Thinking Skill Test	Administration of Critical Thinking Skill Test	1 Day
Achievement Test	Administration of Achievement Test	Administration of Achievement Test	1 Day
Intelligence Test	Administration of Intelligence Test	Administration of Intelligence Test	1 Day
Treatment	Traditional lecture method	Orientation about Blended Learning Strategy **UNIT - I** Concept of Science - Meaning, definition & Scope, Nature of Science, Scientific Attitude - Meaning, Importance and Quality of a person who possesses Scientific Attitude, Scientific Method - Meaning, Importance & Steps **UNIT – II** Bloom's Taxonomy, Instructional Objectives of Teaching Science Pedagogy & Writing them in behavioral terms **UNIT - III** • Approaches and Methods : Inductive, Deductive, Problem Solving, Enquiry, Lecture Cum Demonstration, • Concept Mapping **UNIT - IV** Audio-Visual Aids Classification & Selection), Lesson Plan formats based on different Approaches and Method, Unit Plan	1 Day 8 Days 6 Days 8 Days 12 Days
Post-Tests Critical Thinking Skill Test - Achievement Test	Administration of Post - Critical Thinking Skill Test Administration of Post-Achievement Test	Administration of Post-Critical Thinking Skill Test Administration of Post-Achievement Test	**1 Day** **1 Day**
Reaction Scale		Administration of Reaction Scale	**1 Day**
Interview Schedule	----------	Interview Schedule Conducted	**2 Days**

1.12.0 TOOLS

In the present study, four variables namely, Achievement in Science Pedagogy, Critical Thinking, Reaction towards Blended Learning Strategy and Intelligence were assessed. For assessing the Intelligence, the standardized tool was used. Other three tools namely, Critical Thinking Skill Test, Achievement in Science Pedagogy Test and Reaction towards Blended Learning Strategy were developed by the researcher. Critical Thinking Skillstest was constructed and standardized by the researcher. Researcher made Interview scheduled was employed for the collection of qualitative data.The details of the used tools are given in different captions as follows:

1.12.1 Achievement Test

The Achievement Test was developed by the researcher to assess Achievement in Science Pedagogy. Common content of syllabus of Physics & Chemistry pedagogy subjects of B.Ed. Second Semester course was selected. Achievement Test was based on selected content of four units of the subject Physics Pedagogy& Chemistry Pedagogy. Researcher has framed four unit tests which comprised total 63 questions. The test was comprised of multiple choice questions, one word answer type questions, assertion-reason type questions, Match the columns type questions and subjective type questions. The Multiple Choice questions with four options were prepared in which one was the key (Correct Answer) and the other three were distracters (Similar to the correct answer). In four unit tests total 63 questions were constructed in which 56 question were objective type assigned with 1 mark for each correct answer and 7 questions were subjective type assigned with 2, 3 or 4 Marks respectively, and no mark was deducted for any wrong answer. The maximum score provided for combined Achievement test (Part I to IV) was 80. Test was divided into four parts. The duration of each part of Achievement test was 45 minutes.

The blue Print of the achievement test is presented in table 1.6

Table 1.6

Unit wise, Item wise and Objective wise distribution of the Items in the Test

Unit	Remembering				Understanding				Applying				Higher Level				Total
	MCQ	OW	MC	SQ	MCQ	OW	MC	SQ	MCQ	OW	MC	SQ	MCQ	OW	AR	SQ	
1	- -	1 (1)	- -	1 (4)	1 (1)	1 (1)	4 (4)	- -	2 (2)	1 (1)	-	1 (3)	2 (2)	- -	1 (1)	- -	15 (20)
2	1 (1)	- -	- -	- -	2 (2)	- -	4 (4)	1 (4)	2 (2)	- -	- -	1 (4)	1 (1)	- -	2 (2)	- -	14 (20)
3	- -	- -	- -	- -	4 (4)	1 (1)	- -	- -	2 (2)	1 (1)	- -	- -	1 (1)	1 (1)	3 (3)	2 (7)	15 (20)
4	- -	1 (2)	5 (5)	- -	6 (6)	1 (1)	- -	- -	2 (2)	- -	- -	- -	1 (1)	- -	2 (2)	1 (2)	19 (20)

MCQ : Multiple choice Questions,

OW : One word type Questions

MC : Match the Column type Questions,

AR : Assertion - Reason type Questions,

SQ : Subjective type Questions

( ) : Score / Marks given inside the bracket

1.12.2 Critical Thinking Skill Test

The Critical Thinking Skill Test Was developed and standardized by the researcher. The detail description of the Critical Thinking Skill Test was presented in Chapter 3. The test consisted of 42 items related to eight criteria of Critical Thinking Skill. On the basis of eight criteria of critical thinking skill the test was divided into eight sections (Section A to Section H) . The test is referred to various cognitive skills i.e. analogy, fact, opinion, argument, inferences, deductive reasoning, assumption and comparison skill. For each correct answer one mark was given and no mark was deducted for any wrong answer. The maximum score attainable on the test was 42. The duration of the test is 60 minutes. Section wise and Item wise distribution of the test is give in table 1.7 as follows:

Table 1.7

Section wise and Item wise distribution of the Test

Sections	No. of Items
A (Analogy)	6
B & C (Fact & Opinion)	6
D (Argument)	5
E (Inference)	8
F (Deductive Reasoning)	4
G (Assumption)	7
H (Comparison)	6
Total	**42**

1.12.3 Intelligence Test

From the available tools, the Test of General Intelligence developed by Pal, S.K. and Mishra, K.S. (2012) was selected for assessing the Intelligence of the B.Ed. trainees. The Tool was developed for college students. Test included total 60 items which are divided into six sub test i.e. meaning of words, analytical thinking, classification ability, Numerical ability, ability of code transformation and Inference. Split-half reliability coefficient and Test-retest reliability coefficient of the test is 0.95 and 0.81 respectively. The validity of the test is 0.68. As per manual for each correct answer one mark was given and no mark was deducted for any wrong answer. The range of score of the whole test is from 0-60.

1.12.4 Reaction Scale

A Reaction scale was developed to assess the reaction of B.Ed. Trainees towards the Blended Learning Strategy. 21 statements were constructed on the basis four aspects, namely, Appropriateness of Content, Related to Implementation, Students Center Approach and Usability of Learning resources. Out of them 13 were positive and 8 were negative statements, against each statement a five point scale were given. The five points were Strongly Agree (SA), Agree (A), Undecided (U),

Disagree (D) and Strongly Disagree (SD). The B.Ed. Trainees were given instructions to read the items carefully and put tick (✔) mark on the desired response out of the given five points. The maximum score attainable on the scale was 105 and minimum score was 21. The marking for positive and negative statements according to responses of Strongly Agree (SA), Agree (A), Undecided (U), Disagree (D) and Strongly Disagree (SD) is 5, 4, 3, 2, 1 and 1, 2, 3, 4, 5 respectively.

1.12.5 Interview Schedule

For the collection of qualitative data, six semi structured questions were designed by the researcher for the interview, to know the views of B.Ed. trainees for Blended Learning Strategy on Science Pedagogy. As per the B.Ed. trainees response other related questions were developed during the interview by the researcher.

The summary of the tools used for assessing various variables under this study are presented in table 1.8

Table 1.8

Tools Administered for Assessing Selected Variables under this Research

S.No.	Name of Test	Author	Age	Year	Reliability
1	Achievement in Science Pedagogy	Researcher	21-35	2022	
2	Critical Thinking Skill	Researcher	21-35	2022	0.91
3	General Intelligence Test	Pal and Mishra	College Students	2012	Test-retest: .81 & Split Half .95
4	Reaction towards Blended Learning Scale	Researcher	21-35	2022	---
5	Interview Schedule	Researcher	21-35	2022	

1.13.0 PROCEDURE OF DATA COLLECTION

Permission of the principles of selected Teacher Training colleges were taken for the collection of data. After getting permissions, the rapport with the B.Ed.

Trainees was established. Then the researcher explained them the research objectives. The researcher has administered Pre-achievement Test (Part I to IV) Intelligence Test, and Pre-critical Thinking skill Test on B.Ed. Trainees of experimental group as well as control group. After the orientation program for B.Ed. Trainees of Experimental group the researcher has explained the procedure of learning with Blended Learning Strategy. A college wise group on What's App has been created by the researcher. Mobile numbers of all the 105 B.Ed. Trainees of Experimental group have been collected and simultaneously researcher has added to the college wise Experimental group on what's app using their mobile numbers. Researcher has used Whatsapp group for sharing videos, PPTs and instructional material.Simultaneously assignments were also given on what's app group. So that the B.Ed. Trainees become an active learner.

Format for the strategy was developed by the researcher and content to be taught was arranged in the form of a planner. The B.Ed. Trainees of experimental group started learning through Blended Learning Strategy. Simultaneously, the B.Ed. Trainees of control group started learning through their regular classes. The duration of the treatment was 46 days for both the groups of each college. After the completion of the treatment the researcher has conducted post-achievement test (Part I to IV) and post-critical thinking skill Test on experimental as well as control group. The reaction scale was provided only to the experimental group for receiving reaction of B.Ed. Trainees towards Blended Learning Strategy on Science Pedagogy.

1.14.0 DATA ANALYSIS TECHNIQUES

The objective - wise data analysis techniques are given as follows :

1. One-way ANCOVA was used for comparing the adjusted mean scores of Achievement in Science Pedagogy of Blended Learning Group (Experimental group) with Non Blended Learning Group (Control group) by considering Pre-achievements in Science Pedagogy as a covariate.
2. Two-way ANCOVA was used for studying the effect of Treatment, Intelligence and their interaction on Achievement in Science Pedagogy of B.Ed. Trainees by considering Pre-achievement in Science Pedagogy as a covariate.

3. One-way ANCOVA was used for comparing the adjusted mean scores of Critical Thinking of Blended Learning Group (Experimental group) with Non Blended Learning Group (Control group) by considering Pre-critical thinking as a covariate.

4. Two-way ANCOVA was used for studying the effect of Treatment, Intelligence and their interaction on Critical Thinking of B.Ed. Trainees by considering Pre-critical thinking as a covariate.

5. Reaction towards Blended Learning Strategy of B.Ed. trainees of Experimental Group was analysed on the basis of Intensity Index, Percentage and Coefficient of Variance.

6. To explore the views of B. Ed Trainees of Blended Learning Group on how the Blended Learning Strategy can be treated as a platform for effective teaching-learning process Miles -Huberman (1994) case study method was used, For that qualitative data were collected from the B.Ed. Trainees of Blended Learning Group. Semi- Structured open ended interview schedule was employed for getting the views on Learning Strategy on Science Pedagogy. Most noticeable answers by the B.Ed. Trainees will be used as findings and rest of the data were reduced. The steps involved in analyzing the data collected by the researcher through miles Huberman Case Study method are presented below:

- **Collection of Data :** Data were collected from 15 randomly Selected B .Ed. Trainees through a tool having semi- structured Open ended questions.
- **Condensation / Reduction of Data :** Only those data were selected which were showing significant relation with the quantitative data results.
- **Display of Data :** The Organized information which was accessible for the data analysis has been used for drawing relevant conclusions.
- **Data Verification / Drawing of Conclusion :** Conclusions were verified from the data to be tested for their validity by comparing the conclusions from the quantitative data.

1.15.0 FINDINGS

Objective-wise finding of the present study are as follows:

1. The Achievement in Science Pedagogy of Blended Learning group (Experimental group) was found to be significantly higher to Non-Blended Learning group (Control group) when Pre-Achievement in Science Pedagogy was taken as a covariate.

2.1 No significant effect of Intelligence was found on Achievement in Science Pedagogy when its corresponding Pre-Achievement as a covariate.

2.2 Achievement in Science Pedagogy was found to be significantly independent of the resultant of interaction between Treatment and Intelligence, by considering its corresponding Pre-Achievement as a covariate.

3. The Critical Thinking of Blended Learning group(Experimental group) was found to be significantly higher to Non-Blended Learning group (Control group)when Pre-Critical Thinking was taken as a covariate.

4.1 No significant effect of Intelligence was found on Critical Thinking when Pre-Critical Thinking was taken as a covariate.

4.2 Critical Thinking was found to be significantly independent of the resultant of interaction between Treatment and Intelligence, by taking Pre-Critical Thinking as a covariate.

5. The reaction of the B.Ed. Trainees of Blended Learning group was found to be favorable towards the various aspects of Blended Learning Strategy (i.e. Appropriateness of content, related to implementation, Student centered approach, Usability of learningresources).

6. A better picture of learning has been carved using Blended Learning Strategy. A positive effect on Achievement and Critical Thinking was felt by the learners. Self-paced and face-to-face interaction aspects were appreciated by the B.Ed. Trainees.Think Pair Share activities were appreciated by the eight B.Ed. Trainees and Although five B.Ed. Trainees expressed the need of quiz and debate like activities.

1.16.0 EDUCATIONAL IMPLICATIONS

The findings of the present study concluded that the Blended learning strategy is found effective in terms of Achievement in Science Pedagogy and Critical Thinking among B.Ed. Trainees. Thus, on the basis of present research findings, following implications can be suggested.

For Student-teachers

Blended Learning Strategy is beneficial for studentteachers-. As per the finding of the present study Blended Learning Strategy was found to be effective for enhancing Achievementin Science Pedagogy and Critical thinkingof the B .Ed. .Trainees The reactionof the B.Ed. Trainees towards Blended Learning Strategy is also found favourable. So, it can be said that Blended-learning Strategies can be used for the student-teachers to enhancement of their achievement. Student-teachers can learn with their own pace because providing them self-learningmaterial for Off-CampusStrategy. Also,t hey can revise the concepts while using videos, PPTs and other learning materials at any place, any.time The findings of the present study also states that there is no significant effect of Intelligence on Achievement in Science Pedagogy of B.Ed. Trainees on Critical Thinking, therefore Blended Learning Strategy can be used without bothering about their Intelligence. The findings of the present study also stated that Critical Thinking of Blended Learning group was found to be significantly higher to Non-Blended Learning group, so the student-teachers' Critical Thinking can be enhanced by using different activities like TPS, PS and Discussions related to Critical Thinking.

For Teachers

The findings of the present study shows that Blended Learning Strategy on Science Pedagogy was found to be effective as compared to traditional method of teaching in the enhancement of Achievementin Science Pedagogy and Critical Thinking of B.Ed. Trainees, it can be used by the teachers for an effective teaching-learning process. Teachers can use Blended Learning Strategy on their respective subjects according to the need and availability of resources. As, Intelligence has no significant effect on Achievementin Science Pedagogy and Critical Thinking of the B.Ed. Trainees, hence it provides a common collaborative space for content sharing and personal interactions for learners of low and high intelligence level.T eaching

efficiency of the Teachers can be enhanced by using Blended Learning Strategy in which the content can be taught by face-to-face interaction and with digital medium.

For Teacher-Educators

The Blended Learning Strategy was found to be effective in terms of Achievementin Science Pedagogy, Critical Thinking and Reaction thus it can be beneficial for the Teacher educators. They can train the future teacher in pedagogy and methodology for developing and usingBlended Learning Strategy in the field of educationas for .innovation

For Curriculum Developer

The findings of the present study shows that Blended Learning Strategy on Science Pedagogy was found to be effective as compared to traditional method of teaching in the enhancement of Achievementin Science Pedagogy and Critical Thinking of .B.Ed Trainees, therefore Curriculum can be framedby the Curriculum Developer in such a manner that it can be allow the off-campus and in-campus strategy in teaching-learning process.

For Educational Institutions

As per the finding of the present study Blended Learning Strategyis found to be effective in enhancement of Achievemente Pedagogy . Educational Institutes can organize seminars,workshops and faculty development programs for developing Blended Learning Strategy and how to use Blended Learning Strategyby their teachers in their respective subjects, so that teachers can update themselves and improve the students' Achievement and Critical Thinking .

1.17.0 SUGGESTIONS FOR FURTHER RESEARCH

It is stated that research is an ongoing process, sufficient generalization cannot be made by any study. The present study has its limitations like the previous studies. There is a need to find the scope for further researches. Therefore, suggestions are presented for furthers studies:

- The present research conducted on Trainees of B.Ed. colleges affiliated to Devi Ahilya Vishwa Vidyalaya, Indore. Similar research study can be conducted on Trainees of other B.Ed. colleges affiliated to other universities.

- Similar research study can be conducted on other subjects of Education, for the B.Ed. Trainees.
- In Future researches can be conducted by taking other dependent and secondary independent variables like Scientific Attitude, Science Process Skill, Study Habits, Personality and so.on,
- These type ofresearches may be conductedto study the impact of various demographic variables like Gender, Residential and Medium of Instructions.
- In the present study flipped model of Blended Learning was used. Further researches may be conducted with other models of Blended Learning.
- The further researches can be conducted on comparative analysis of Blended Learning Strategy with other Instructional Strategy.
- Further researches can be conducted a Blended Learning Strategy for School education & Higher education.

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