THE IMMERSION OF BLENDED LEARNING AND PADAGOGICAL APPROACHES TO ENHANCE PRE-SERVICE TEACHER CRITICAL THINKING SKILLS IN NIGERIA

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Abstract: The study examines the effectiveness of station rotation model in blended social collaborative learning environment in enhancing pre-service teachers critical thinking skills in Nigerian University. two sets of instruments were used to collect pre-test and post-test data from experimental and control groups with a sample of 108 n = 54 each from the two groups. An independent sample t-test was conducted to determine the mean difference between two groups. The results of the study show that their significant difference in the mean scores conventional approach and station rotation in blended social collaborative learning environment group I terms of critical thinking skills. The intervention groups (SRM-BSCLE) scored the highest mean score in the critical thinking skills test on both instruments as compare to the conventional group. Further results of the five sub-dimensions of critical thinking in General Critical Thinking and Teaching Method related Critical Thinking also indicated significant findings in General Critical Thinking except in one sub-dimension of Inference, while the teaching method related critical thinking did not show significant results in deduction but have shown in the remaining four sub-dimensions. Therefore, the findings of the study revealed that station rotation model in blended social collaborative learning environment group has scored high in critical thinking as compare to the conventional approach group.

Keywords: Station Rotation Model; Blended Learning; Collaborative Learning; Social Learning.

I. INTRODUCTION

In the 21st century, the field of education has witnessed a massive transformation and innovations presented by modern technology and the blended pedagogical approaches needed to promote classroom teaching and learning. However, this transformation has not been tapped in the realm of education sector in underdeveloped nations. This scenario has affected all sectors including teaching and learning arena. To be more detail, the teacher education program for teacher trainees has badly hit by the incessant application of crude learning that does not promote critical thinking among pre-service teachers. Therefore, there is widespread concern over the lack of productivity and inferior quality of teachers by means of traditional teaching strategy. As a result, this has instigated the institution of learning

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to consider variety of teaching strategies to encourage effective learning outcome to improve learners' achievement.

The application of blended learning may ensure effective delivery of teaching and learning [59]. This is because an effective development of teaching and learning skills among pre-service teachers, especially through the application of blended learning strategies might help them learn the basic of transferring critical thinking to their future students. [1] suggested that training, workshops and seminars should be organized to sensitize teachers to use blended learning in their classroom. Schools should also be equipped with facilities such as computers and high-speed Internet connection to enhance blended learning among pre-service teachers. Blended learning couple with student centered pedagogical approach to learning is found to be in enhancing critical thinking among learners [60].

However, there are factors that hinder the application of learning environment that incorporates constructivist approach and the required technologies into classrooms in developing countries [7]. [28] assert that factors such as inadequate financial resources, infrastructure, human capital management support, lack of computer literacy, behavioral and environmental factors are hindering the application of modern technologies in classroom across many developing countries. This aforementioned factors may distort proper learning and it might lead to render learners to leack thr basic skills to handle their academic prowess. Therefore, the purpose of this paper is to examine the application of station rotation model in a blended social collaborative learning environment to enhance pre-service teachers critical thinking skills.

II. THEORETICAL BACKGROUND

There are several theories of learning that attempt to solve different learning problems with the sole aim of enhancing teaching and learning, some of these theories are specifically developed to promote classroom collaboration and social interactions among learners. There exist three measure theories of learning, namely: the constructivism, behaviorism, and cognitivist. The degree of significance exhibit by these theories in promoting the quality of teaching and learning cannot be underestimated. This study employed one branch of constructivist theory to examine the effect of station rotation blended learning model in blended social collaborative learning environment to enhance critical thinking among pre-service teachers. Constructivism is a branch of learning theories that deals with how learners construct their knowledge through experience and learning in active process [63]. Constructivist approach promotes skills, procedures, and computation, which in return may render students less productive in terms of meeting up with the prevailing challenges from outside their environment. Constructivism has a major influence in the field of education research. One of the fundamental aspects of the theory is

that learners construct their knowledge and understand basic concept, as against been a passive listener in the classroom. This theory encourages full pledge learners centered approach to learning whereby teachers' role is minimal, they served as facilitators, they are expected to only provide guidance to students as at when due. People can learn by doing [64].

The inability of student to apply what they learned in to real world situation might be as a result of lack of critical thinking skills. Similarly, student who cannot classify, analyze, generalize, deduce, and induce proper solution to problems lacks the basic thinking skills. In order to promote this, the teacher will employ collaborative and social learning teaching techniques with blended learning using a screencasts video to allow students to interact. An interactive engagement (IE) has a significant impact on improving students' critical skills [37]. So, if the teacher allows students to interact with content, technological gadget, as well as among their peers, it may improve on their academic performance. Student ability to interpret information provided by the teacher depend on how student contextualized subject matter by applying what is learned in different outlook [75].

Vygotsky is the one that conceived the idea of Zone of Proximal Development (ZPD), he started exploring the concept in 1920s. Vygotsky is generally known for his general genetic law of cultural development, which makes him famous in the field of cognitive development, he define zone of proximal development (ZPD) as *"the distance between the actual development level as determine by independent, problem solving under adult guidance, or on collaboration with more capable peers" pp33*. This implies that there is the need for teachers to create room for learners to interact with their peers, this according to him, will effectively help the child in developing skills and strategies. Similarly, according to [86], the role of a teacher is to provide assistance to students, as they are engaged in a cognitive task. Vygotsky's ZPD will help us understand what learner is able to do and understand.

A. Critical Thinking among Nigerian Pre-service Teachers

Several studies on critical thinking in Nigeria have pointed out the possibilities of lack of critical thinking skills among students at various levels of education ([2], [4],[5], [70]). This according to the studies is as a result of factors such as lack adequate teaching infrastructure, inadequate qualified teaching personnel and lack of innovation that rendered most of the faculty members to heavily rely on teaching approach that does not encourage critical thinking skills among students in various levels of education. Seemingly, most of teaching staff in Nigerian institutions of higher learning is predominantly dominated by traditional lecture teaching techniques, which does not encourage critical thinking ([4] [6] [18] [31], [42] [61]. Teacher training institutions in Nigeria is surrounded by the rampant application

of teaching techniques that does not promote critical thinking among pre-service teachers. Thus, institutions of higher learning around the world are being challenged to provide learners with the skills and knowledge to meet the demand for workforce, for them to contribute to the dwindling global economy [12].

There exist many complaints in the Nigeria's labor market that majority of graduate students lack critical thinking skills that render the system unproductive [3], [18], [70], [76]). These researchers argued that lack of critical thinking among Nigeria students is in persistent and the need to realign it pedagogical principles and an effective teacher training scheme that inculcate critical thinking, might help in producing novice teachers that will transfer those acquired skills to their students. This have triggered the need for immediate intervention to instill critical thinking into teacher education so that students from all level might have these skills in solving personal and organizational problems. Thus, there is little, or no effort was made to improve criticsl thinking in Nigeria [58] and this has lead the researcher to embark on this present journey to explore this area and highlight its importance in national development.

Thus, this research work was conducted in one of the faculty of education in a national university located at northeastern part of Nigeria, where critical thinking is partially embedded in curriculum and in the 2004 national policy on education [77]. Many graduates of faculties of education in Nigerian universities who are prospective teachers do not have the intellectual skills and capabilities especially of critical thinking [42], these sets of pre-service teachers are deployed to various primary and secondary schools to teach pupils and students. Therefore, well-designed learning activities that involved content, technology, and pedagogy can improve both critical thinking disposition and learning outcome of pre-service teachers [68].

Appropriateness of teaching method could lead to the enhancement of pre-service teacher's critical thinking skills [89]. Constructivist learning environment is found to be effective in enhancing critical thinking abilities of student (Patamaporn, 2015). Previous research studies revealed that students' critical thinking could be enhanced when it is taught through effective pedagogical approach [69]. There are many approaches of teaching students to develop critical thinking skills, some of the major pedagogical approach of teaching critical thinking is the collaborative and social approach to learning. These approaches are believed to enhance student critical thinking skills [55]. Some practitioners and educators have endorsed collaborative leaning as one of the effective pedagogical approach to teaching critical thinking. However, there are fewer or no studies that highlighted the practice of collaborative learning is eligible to enhance critical thinking among pre-service teacher. Thus, the pre-sent study is unique to incorporate the application of collaborative learning to enhance pre-service teachers.

B. Collaborative and Social Learning Environment

Collaborative pedagogical approach is one of the teaching strategies that enhance critical thinking ([71], [87], [89], it provides the means to organized learners for a small group learning. This could be achieved by teacher through helping students to collectively think and find solution to problems [89]. Similarly, collaborative learning is believed to enhance students' social skills required for them to succeed. Research has proven that collaborative strategies do not only help students to learn academic content, but it also provides them with the required skills needed in developing and enhancing their critical thinking abilities [19] In order for collaborative strategies to be effective, teachers need to employ an effective collaborative that involves group learning that encourages social interaction, skills to go beyond the classroom boundaries [19] Several practitioners have developed collaborative approaches that serves as a guiding principle capable of creating a collaborative learning environment ([67], [40], [43], [51]). These collaborative approaches are very critical in the application of classroom teaching and learning. Practically speaking, all the authors have demonstrated similar degree in the approaches with very little differences in their presentation (See Table 2.2), in this study, Dillenbourg's four approaches to collaborative learning chosen to guide the aspect of collaborative learning. These four approaches is widely used in teaching and learning collaborative learning and these were found it to be effective (Kim, Lee, & Kim, 2014), especially in computer mediated learning environment.

Collaborative approach to teaching provides room for students to interact with their peer and it also provides sufficient ground for student to have multi-dimensional approaches to acquire skills among their collaborative group [83]. On the other hand, collaborative learning was found to enhance student learning as compare to conventional approach to teaching, which always renders learners passive. Collaborative approach to learning is found to have positive influence on students' academic performance [83]. There is strong indication that collaborative learning promotes traditional classroom and it bring about relationship between teacher and student [56]. Conversely, in a traditional classroom the teacher controls the affairs of learning environment in a traditional teaching technique [56], similarly, the lecturer serves as a custodian of knowledge with the power to decide the curriculum content and specific outcome as sole provider of knowledge [56]. Thus, collaborative teaching is found to be an additional stimulus to enhance learning as against the traditional teaching approach [26]

Social constructivism plays a leading role in moving away from transmissive approach to leaning to a collaborative learning which is aimed at acquisition of critical thinking among learners [80]. In a teacher education program, the use of strategies for engaging learners in collaborative learning alone may not suffice the learning needs of learners. Therefore, in order to close the learning gap of confining

only to in-group interaction or collaboration, the need to broaden the learning environment to engage in group to group and learner to teacher by injecting social presence through Vygotsky's Zone of Proximal Development is paramount.

C. Station Rotation Blended Learning Model

According to [34] there are several ways of implementing blended learning. One of these may occur through the application of station rotation model. The model allows learners to rotate between online learning and other learning modalities through fixed schedule by teachers' discretion. Similarly, all practitioners in the field educational technology who have developed curios interest in the study of blended learning have agreed to the fact that station rotation model of blended learning is the act of allowing learners to rotate in a fixed scheduled or in a discretion of the teacher to allow them to rotate in different learning modalities to improve their learning outcome ([13], [20], [66], [39]).

Moreover, this blended learning model includes the following: small group instruction, group project, individual tutoring, and paper and pencil assignment given to learners [39]. In this study, the implementation of blended learning was carried out based on station rotation model. Though, it has been stated that the level of execution of this type of blended learning model should carry any of the following: subjecting the whole class to different activities at a point in time or divide the class into small groups to allow collaboration among groups [13]. It is on this note that the researcher adapted the small group of station rotation to allow collaboration and rotation across different learning modalities among learners. This research did not stop at allowing small group learning, and or allowing learners to rotate around different learning modalities but it went beyond boundaries to identify pedagogical strategies like collaborative in its fullest to encourage active learning participation with peer interaction in classroom instruction. This learning approach is believed encourage learners to perform better and also enhance their critical thinking [66]. Therefore, the need for the incorporation of this model in study was necessitated by a number of positive attributes requires for the implementation of the learning environment that combines several learning modalities among learners that was believed to resolve issues of dissecting the over populated classroom in to manageable units [34].

III. METHODOLOGY

In order to achieve the objectives and the research questions covered by this study, a quasi-experimental design with pre-test and posttest between control and experimental groups were administered to determine whether the application of SRM-BSCLE in enhancing pre-service teachers critical thinking skills. A Quasi-experimental design approach was conducted to collect data from the participants.

Which implies that the data on critical thinking, of pre-service teachers who were selected using nonrandom selection to participate in the study was manipulated in a experimental group: A treatment group consisting of pretest and posttest with an intervention (SRM-BSCLE) and the control group (content with conventional teaching approach) to determine whether application of blended social collaborative learning environment to enhance pre-service teachers critical thinking. Data was used to determine the effect of SRM-BSCLE on pre-service teachers learning. Pre-service teachers' data was collected base on control and experimental groups pre and posttest differences in critical thinking skills. The design was quasi-experimental whereby participants are assign into two different conditions of control and experimental groups (pretest and posttest).

A Quasi-experimental is a design in which participants are selected based on nonrandomized to the groups. The choice of a quasi-experimental design in this study was that it might not be possible to assign subjects to a treatment randomly in a school set up neither the school authorities allow a researcher to randomly assigned students to a particular class for research purposes [27]. In order to answer the research questions raised in this paper, the design chosen is more appropriate in terms of convenient. Moreover, it provides a detail and in-depth explanation of the research questions. This research employed nonrandomized control and experimental groups pretest posttest design. This design is of very practical in educational setup because it is meant to measure report about the value of a new teaching techniques or curriculum innovation.

The nonrandomized control and experimental group pretest and posttest design can be represented by the following assumptions. The nonrandomized quasi experimental groups with pre and posttest is as follows:

TABLE 1. NONRANDOMIZED QUASI-EXPERIMENTAL DESIGN

Group	Pretest	Intervention	Posttest
E_1	O_1	X_1	O_3
C_1	O_2	-	O_4

A. Research Questions

Two research questions guided the present study:

1. What are the effectiveness of critical thinking of pre-service teachers experienced station rotation blended learning model in blended social collaborative approach compare to those exposed to conventional approach?

2. What are the effectiveness of teaching method based critical thinking of pre-service teachers experienced station rotation blended learning model in blended social collaborative approach compare to those exposed to conventional approach?

B. Research Setting and Participants

The research was conducted in the faculty of education of in university of Maiduguri Nigeria with one hundred and eight science major pre-service teachers (n = 54) conventional approach group and station rotation model in blended social collaborative learning environment group (n =54). All the research participants were enrolled to undertake methodology course for methods of teaching science for first semester and they all agree to participate in the study. The course was taught using a blended learning model; the instructor engaged the pre-service teachers with and without intervention. The content with intervention was manned by Vygotsky's social learning theory through application of blended social and collaborative learning environment and later test it on the basis of improving pre-service teachers' critical thinking skills.

Moreover, a purposive sampling was used to select participants for the main study, where the researcher specifies the characteristics that match the characteristics chosen to participate in the study [22]. It is important to note that a nonprobability sampling is more convenience in an educational setup. For example, it is not easy for a principal or a faculty member to permit a researcher to use probability sampling to select sample for their study because its looks awkward to scatter a class of students simply for conducting a research, this form of sampling is the degree to which the researcher sample elements judge to be typical from the population [27]. In this study, a total of 108 pre-service teachers registered for the module of methods of teaching science, the researcher adopted and divide them proportionately based on the registered pre-service teachers to the experimental and control groups.

C. Instruments

The researcher used two sets of questionnaires to answer the research questions for this study, namely, Watson Glaser Critical Thinking Appraisal (WGCTA) Form A and B, Teaching Method Based Critical Thinking Appraisal (TMCTA. A multiple choice practical and achievement to pretest and posttest was adapted by the researcher to assess the students' level of critical thinking skills among learners. The research employed an instrument on Watson Glaser Critical Thinking Skills Assessment (W-GCTA) form A and B. The rationale behind choosing W-GCTA "A & B" was that the instrument is widely accepted and used by many researchers to assess critical thinking of pre-service teachers. W-GCTA is five constructs from cognitive areas: inference, recognition of assumption, deduction, interpretation, and evaluation of argument. These areas measure the levels of assessment of critical thinking outcome. The instruments' alpha reliability ranges from other researches cohort with the present study's, the previous studies reliability was found to be 0.70 to 0.86. W-GCTA is 80 items that cut across the five test areas that has in it both neutral and controversial scenarios and reading passage, which is encountered in a

classroom set up and other fields of endeavor. Most specifically, the inventory is widely used in fields of teaching and learning, recruitment, training, work places, and media houses [53]. It took respondent 80 to 90 minutes to complete the standard paper and pencil form A and B, W-GCTA is one of the widely use assessment of critical thinking around the world of education and workforce. The questionnaire uses a multiple choice and Likert scale response type.

The 80 items questionnaire by [88] is in reality available in Pearson website for free to use by researchers. The questionnaire was created to measure general critical thinking around the world. In order to adapt this questionnaire to suit the current study, the researcher went further to look for same type questionnaire that was use in a recent study which used in science background pre-service teachers by[30].

Similarly, the second instrument used in present study is a 45 items questionnaire which was adapted and modified from the WGCTA. The questionnaire which was named Teaching Methods Critical Thinking Appraisal (TMCT) has followed the five sub-dimensions of WGCTA and carefully rephrase the items to reflect teaching methods. This was carried out to help the researcher measure pre-service teachers critical thinking in teaching method. The reason for employing this questionnaire is to make sure that the research participant who are taught in a learning environment that was designed to promote critical thinking skills of pre-service teachers have shown significant improvement in their critical thinking based on methods of teaching.

D. Intervention

The development of intervention program was conducted via three phases that include analysis stage, design and development stage, and the implementation and evaluation stage. The study adopted ADDIE model [54] of instructional system design to help guide the need analysis and the entire development and implementation of the research work. Therefore, the program followed stages involved in ADDIE model, the design stage is aimed at identifying the level of critical thinking of pre-service teachers by conducting a need analysis in one of the centrally cosmopolitan public university with national outlook degree awarding institution in Nigeria. The study focused on designing and developing a blended social collaborative learning environment to enhance critical thinking among pre-service teachers. The blended learning technique employed was station rotation model coupled with teaching strategies and computer mediated instructions. The last and final stage of the study focused on implementation and evaluation of the outcome of the second phase. The researchers in this section focused on how to administer the treatment to the pre-service teachers. The research assistant administered the treatment to the station rotation model in blended social collaborative learning environment (SRM-BSCLE) group; this was achieved through pre-test and post-

test, whereby the control and experimental groups of pre-service teachers were tested using conventional method of teaching and teaching with intervention. The SRM-BSCLE group was provided with the treatment (post-test) to see the effect of the intervention. However, it is expected that the intervention improves pre-service teachers' critical thinking skills.

i. Phase One: Analysis

Based on the outcome of the need analysis which shows that there is based on arranging the required facilities and activities needed for the conduct of the study to enhanced of critical thinking skills among pre-service teacher. These include the participants analysis, technology analysis, situation analysis, task analysis, and objective analysis. After accomplishing the fore mentioned analysis, the researchers felt that there was the need to embark on the study. Thus, the researchers went ahead to create a blended social collaborative learning environment (BSCLE) to determine effectiveness of critical thinking skills among pre-service teachers. A blended instruction with face to face and computer mediated instruction that allows collaboration and socialization among learners through one of the blended learning model (station rotation), where learners are allowed to be fixed on content or course while other groups of leaners in a different task.

ii. Phase Two: Design and Development

The second phase of the study was aimed at designing and developing a blended learning environment as an intervention in the existing pre-service teachers' curriculum with particular emphasis to Methods of Teaching Science. The topic areas to be affected by the learning environment should one of the pedagogical courses of pre-service teachers (science teaching method), the researcher sought for experts' advice to know the gray areas and also identify the problem areas and improved on the learning content. This learning environment was designed to target pre-service teachers in one of the teachers training institution within the confine of the study.

Therefore, the desired outcome of the study was to enhance pre-service teachers' critical thinking skills and the end product of the design was based on station rotation blended learning model for supporting collaboration and social interaction among learners. The development phase of the study, which was, based on the detail on design. The researcher developed the blended social collaborative learning environment with the aid of subject matter experts (SMEs). These experts who are SMEs and educational technologist were drawn from the faculty of education in university of Maiduguri and Federal University Gashua, they were expected to oversee the production and the pedagogical aspects and offer advice on the best conceivable way of improving the station rotation blended learning model, their role was very vital in creating the blended learning environment with pedagogical

principles. The aim was to design and develop BSCLE to enhance critical thinking among pre-service teachers in Nigeria.

iii. Phase Three: Implementation and Evaluation

The third and final phase of the study comprise of the implementation and evaluation process. The implementation of the station rotation blended learning model was conducted from September to October 2017 in 2017/2018 academic sessions in the faculty of education in university of Maiduguri; this was conducted within the intervention period. The pre-service in experimental group was the only group allowed to receive the intervention, their role during the process of implementation was: participate in collaborative group, surfing internet, watching the instructional video, engaging in a collaborative work, doing group work, assignments, and peer to peer interaction. The learning environment was designed to be guided by station rotation model to engage pre-service teachers in the experimental group in different learning modalities. In this phase, the research participants are to rotate across the above listed learning modalities to study.

The evaluation phase in this study occurred in all the phases covered by this research work. Thus, formative evaluation took place in design, development, and implementation phases, while the summative evaluation was conducted after implementing the intervention. Similarly, the evaluation was determined by the outcome of the implementation process, this was achieved by subjecting both control and experimental groups to pre-test and post-test with intervention (Experimental Group) and no intervention (Control Group).

VI. DATA ANALYSIS

The study analyzed the collected data from the participant by first analyzing the quantitative data followed by the qualitative data. Both quantitative and qualitative data was collected one after the other ([23], [24]). Firstly, the researcher analyzed the quantitative database on the questionnaires, the data collected was analyzed using statistical tool for analyzing quantitative data. A descriptive analysis and Independent sample t-test was tested on research questions address by the present study. The data collected was subjected to statistical tool for analyzing numerical data. The quantitative data was carefully screened to identify and reduce all issues related to missing values and outliers

In this study, inferential statistics of independent sample t-test was employed to analyze the difference in mean scores of between groups. An independent sample t-test was used to compare the mean scores of two distinct groups. In order to answer research questions two questionnaires on critical thinking; General Critical Thinking (Watson Glaser Critical Thinking Appraisal Form A for pre-test, form B post-test) and Teaching Method Based Critical Thinking Appraisal (pre-test

and post-test). Both WGCTA form A and B have five sub-dimensions with scores ranging from 16 to 15 per each sub dimensions, the total score of the two question is 80 marks, while, the TMCTA constitute of 45 marks scattered across five sub dimensions measuring critical thinking. Pre-service teachers are expected to answer all the multiples choice questions correctly to achieve an elevated level of critical thinking skills.

V. RESULTS

The presentation of results in this research work was conducted base on the two major research questions that this study aimed to addressed. This may include: What are the effectiveness of critical thinking of pre-service teachers experienced station rotation blended learning model in blended social collaborative approach compare to those exposed to conventional approach? and What are the effectiveness of teaching method based critical thinking of pre-service teachers experienced station rotation blended learning model in blended social collaborative approach compare to those exposed to conventional approach?

A. Comparison of Critical Thinking Skills of Experimental and Control Group

In order to compare the results of critical thinking scores of station rotation model in blended social collaborative learning environment research question 2 was used to addressed the section "What are the effectiveness of critical thinking of pre-service teachers experienced station rotation blended learning model in blended social collaborative approach compare to those exposed to conventional approach?"

Table 5.11 below shows the analysis of the comparison of critical thinking skills of the two study groups in the study. The result shows the mean and standard deviation of the pre-test and post-test of the overall groups. The data was analyzed through inferential statistical analysis called independent sample t-test. The rationale for the conduct of this test is to find whether there is difference between the mean scores of control and experimental groups.

An independent sample t-test was carried out to compare the means score of control group that received instruction through conventional approach and experimental group received instruction with station rotation model in a blended social collaborative learning environment. The difference between the mean scores of controlled group's n = 51 (M = 41.12, SD = 3.25) was found to be significantly lower (t (102) = 18.9, p < 0.05) than the mean score of experimental group (n = 53, M = 62.43, SD = 7.49. Furthermore, a detail analysis of critical thinking sub-dimensions measured by the instrument showed significant statistical difference between control and experimental groups. For example, Inference: independent sample t-test (t = 15.3, p = 0.00 < 0.05). Assumption: independent sample t-test (t = 12.1, p = 0.00 < 0.05). Deduction: independent sample t-test (t = -10.2, p = 0.00 <

0.05). Interpretation: independent sample t-test (t =9.39, p = 0.00 < 0.05). Evaluation of Argument: Independent sample t-test (t = 10.1, p = 0.00 < 0.05). Table 5.11 indicates the results oft he independent sample t-test for general critcal thinking.

TABLE 2. MEAN SCORE FOR GENERAL CRITICAL THINKING MARKS

Critical Thinking Constructs	M and SD	Control group pretest (n=54)	Control group posttest (n=51)	Experimental group pretest (n=54)	Experimental group posttest (n=53)	t value post-test	P Value	Mean Difference in Post-test
Inference	Mean	4.89	8.49*	4.70	13.23*	t = 15.3	.000*	4.74
	SD	2.01	1.29	1.42	1.82			
Assumption	Mean	4.91	8.20*	5.00	12.74*	t = 12.1	.000*	4.54
	SD	1.95	1.52	1.24	2.25			
Deduction	Mean	4.30	8.33*	5.52	12.25*	t = -10.2	.000**	3.99
	SD	2.44	1.89	1.29	2.03			
Interpretation	Mean	4.30	9.06*	5.06	13.23*	t = 9.39	.000*	4.469
	SD	2.44	1.95	1.81	2.52			
Evaluation Argument	Mean	3.75	7.04*	4.81	10.85*	t = 10.1	.000*	3.621
	SD	1.82	1.74	1.38	2.10			
Overall	Mean	22.11	41.12*	25.07	62.43*	t = 18.9	.000*	21.32
	SD	6.04	3.25	5.09	7.49			

The above data analysis has shown a remarkable difference between control and experimental groups. The five major constructs of critical thinking were measured using WGCTA form "A" and "B." These include inference, assumption, deduction, interpretation, and evaluation of argument. The analysis of the results shows that there is significant improvement on the critical thinking skills of pre-service teachers after the intervention ([8], [73]). Therefore, based on the overall outcome of the study on pre-service teachers critical thinking skills, the results show that there is statistically significant difference between control and experimental groups. Similarly, findings of the independent sample t-test based on the five constructs measured by critical thinking show a statistically significant difference between experimental and controlled groups. Therefore, the assumption criterion of experimental group secured higher than the controlled group.

B. Comparison of Critical Thinking Skills Associated with Teaching Method of Experimental and Control Groups

This section deals with comparing the results of based critical thinking scores associated with teaching method of station rotation model in blended social

collaborative learning environment research question 3 was used to address the section "What are the effectiveness of teaching method based critical thinking of pre-service teachers experienced station rotation blended learning model in blended social collaborative approach compare to those exposed to conventional approach?"

Table 5.12 shows comparison of critical thinking skills of post-test results of control and experimental groups. After conducting the teaching through conventional teaching to the pre-service teachers, a significant improvement was recorded in the levels of critical thinking of pre-service teachers. The experimental group performance was considered to be higher as compare to control group, the mean score for experimental group (M = 30.528, SD = 3.734), whereas the mean score of control group was found to be (M = 17.647, SD = 4.156). Moreover, the overall results of the two groups in terms of inferential statistics of independent t-test is sig. (2 tailed) t = -16.6, p (102) = 0.00 < 0.05. Moreover, a detail analysis of critical thinking constructs measured by the instrument showed significant statistical difference between control and experimental groups. For example, Inference: independent sample t-test (t = -12.7, p (102) = 0.00 < 0.05). Assumption: independent sample t-test (t = -10.8, p (102) = 0.00 < 0.05). Deduction: independent sample t-test (t = -1.98, p (102) = 0.00 < 0.05). Interpretation: independent sample t-test (t = -10.4, p (102) = 0.00 < 0.05). Evaluation of Argument: independent sample t-test (t = -11.1, p (102) = 0.00 < 0.05).

TABLE 3. MEAN SCORE FOR CRITICAL THINKING MARKS ASSOCIATED WITH TEACHING METHOD

Critical Thinking Constructs	M and SD	Control group pretest (N=54)	Control group posttest (N=51)	Experimental group pretest (N=54)	Experimental group posttest (N=53)	t value post-test	P Value	Mean Difference in Post-test
Inference	Mean	2.722	2.647*	2.574	6.849*	t = 12.7	.000	4.20
	SD	1.433	1.426	1.426	1.915			
Assumption	Mean	3.352	3.824*	3.019	6.906*	t = 10.8	.000	3.08
	SD	1.544	1.584	1.460	1.319			
Deduction	Mean	3.019	4.333*	2.759	3.811*	t = 1.98	.051**	.522
	SD	.8352	1.451	.7232	1.226			
Interpretation	Mean	2.482	3.314*	2.289	6.132*	t = -10.4	.000	2.82
	SD	1.384	1.490	1.306	1.272			
Evaluation Argument	Mean	3.148	3.529*	2.815	6.830*	t = 11.8	.000	3.30
	SD	1.472	1.501	1.150	1.312			
Overall	Mean	14.72	17.647*	13.42	30.528*	t = 16.6	.000	12.88
	SD	3.230	4.156	3.100	3.734			

The findings of the table above show an outstanding difference between control and experimental groups. The independent sample t-test of the five major constructs of critical thinking were measured using critical thinking based on teaching method. These include inference, assumption, deduction, interpretation, and evaluation of argument. The analysis of the results shows that there is significant improvement in the critical thinking skills of pre-service teachers after the intervention ([62],[82]). Therefore, based on the overall outcome of the study that comprised of all the five sub dimensions measured by critical thinking based on teaching method on pre-service teachers critical thinking skills, the results show that there is statistically significant difference between control and experimental groups. Similarly, findings of the independent sample t-test according to the independent constructs also indicate that there is statistically significant difference between experimental and controlled groups. Therefore, the assumption criterion of experimental group secured higher than the controlled group.

C. Mean Differences for Post-test Results of Control and Experimental Groups on Critical Thinking

The mean scores of pre-test results of the experimental group and control in general critical thinking indicate minor differences that shows insignificant statistical relationship. However, a significant difference was noticed in the post-test results of the two groups under study. Table 5.13 below shows that the critical thinking, post-test mean scores M = 62.43, SD = 7.49 of the experimental group is significantly higher than the mean scores of control group which is M = 41.12, SD = 3.25. Additionally, a detail analysis of the findings of five constructs measuring pre-service teachers' critical thinking skills show a significant mean difference between the control and experimental groups, with latter showing higher mean score than the former. These results were highlighted in table 5.13 below to show the profile of five sub-dimensions of critical thinking to determine the scores of control and experimental. The five sub-dimensions mean score shows that experimental group performed better than control group. For example, the mean score on inference of experimental group is M = 13.23, SD = 1.815, against control group M = 8.49, SD = 1.286. Also, the mean scores on Assumption of experimental group is M = 12.674, SD = 2.246, against control group M = 8.196, SD = 1.523. Similarly, the mean scores on Deduction of experimental group is M = 12.25, SD = 2.028, against control group M = 8.333, SD = 1.894. The mean scores on Interpretation of experimental group is M = 13.23. SD = 2.524, against control group M = 9.059, SD = 1.954 and lastly, the means scores on evaluation of argument of experimental group is M = 10.85, SD = 2.098, against control group M = 7.039, SD = 1.743.

TABLE 3. DESCRIPTIVE AND INFERENTIAL STATISTICS OF CONTROL AND EXPERIMENTAL GROUPS ON POST-TEST FOR CRITICAL THINKING SCORES

Constructs	Control Group (N = 54)		Experimental Group (N = 54)		t - test	
	Mean	SD	Mean	SD	t	p
Inferential	8.49	1.29	13.23	1.815	15.3	0.00
Assumption	8.20	1.52	12.74	2.246	12.1	0.00
Deduction	8.33	1.89	12.25	2.028	10.2	0.00
Interpretation	9.06	1.95	13.23	2.524	9.39	0.00
Evaluation of Argument	7.04	1.74	10.85	2.098	10.1	0.00
Overall	41.12	3.25	62.43	7.485	19.0	0.00

The results of the independent sample t-test showed a statistically significant difference between control and experimental groups, this means that critical thinking skill of experimental group is significantly higher than that of control group. Furthermore, based on the post-test results according to the five sub-dimensions measured on critical thinking the pre-service teachers that took part in the experimental group have performed significantly well in all the five sub-dimensions. Thus, the mean scores of pre-service teachers in experimental group from all the five sub-dimensions under consideration was significantly higher as compare to the mean score of control group. Therefore, the result of this study indicated that teaching pre-service teachers with station rotation model in a BSCLE was found to be more effective in enhancing pre-service teachers critical thinking skills as compare to teaching with conventional approach to learning.

D. Mean Differences for Post-Test Results of Control and Experimental Groups on Critical Thinking Associated with Teaching Method

The mean scores of pre-test results of the experimental group and control in TMCTA indicate minor differences that are not statistically significant. However, a significant difference was noticed in post-test results of the two groups under study. Table 5.14 below shows analysis of result on critical thinking based on teaching method, the overall post-test means scores of experimental group (M = 30.528, SD = 3.734) is significantly higher than the scores of control group which is (M = 17.647, SD = 4.156). Additionally, a detail analysis of the five constructs measuring pre-service teachers' critical thinking skills was conducted to see the results of the mean scores independently. These results were highlighted in table 5.14 below to show the profile of five sub-dimensions of critical thinking based on teaching method to determine the scores of control and experimental groups.

The five construct's mean difference shows that experimental group performed better than control group. For example, the mean score on post-test for inference in

experimental group is M = 6.849, *SD* = 1.915, against control group M = 2.647, *SD* =1.426. Also, the mean scores on Assumption of experimental group is M = 6.906, *SD* = 1.319, against control group M = 3.824, *SD* = 1.584. Similarly, the mean scores on Deduction of experimental group M = 3.811, *SD* = 1.226, against control group M = 4.333, *SD* = 1.451. The mean scores on Interpretation of experimental group is M = 6.132, *SD* = 1.272, against control group M = 3.314, *SD* = 1.490 and lastly, the means scores on evaluation of argument of experimental group is M = 6.830, *SD* = 1.312, against control group M = 3.529, *SD* = 1.501.

TABLE 4. DESCRIPTIVE AND INFERENTIAL STATISTICS OF CONTROL AND EXPERIMENTAL GROUPS ON POST-TEST FOR CRTICAL THINKING ASSOCIATED WITH TEACHING METHOD SCORES

Constructs	Control Group (N = 54)		Experimental Group (N = 54)		t - test	
	Mean	*SD*	*Mean*	*SD*	*t*	*p*
Inferential	2.647	1.426	6.849	1.915	-12.65	.000
Assumption	3.824	1.584	6.906	1.319	-10.80	.000
Deduction	4.333	1.451	3.811	1.226	1.98	.052
Interpretation	3.314	1.490	6.132	1.272	10.39	.000
Evaluation of Argument	3.529	1.501	6.830	1.312	-11.95	.000
Overall	17.647	4.156	30.528	3.734	-16.64	Sig. .000

Base on the findings of the independent sample t-test on post-test for the five constructs in critical thinking based on teaching method altogether showed a statistically significant difference between control and experimental groups, this means that critical thinking skill of experimental group is significantly higher than that of control group. Furthermore, based on the post-test results according to the five constructs measured on critical thinking based on teaching method. The pre-service teachers who took part in the experimental group have performed significantly well in all the five constructs. Though, a noticeable disparity in terms achievement in those constructs for the post-test in the experimental group was recorded, it has been concluded that a statistically significant difference in the mean scores of control and experimental group was discovered. For example, the post-test means scores of experimental group in deduction (Asterisk* table 5.14 above) is lower as compare to the rest, while the remaining four constructs: inference, assumption, interpretation, and evaluation of argument were than the remaining two sub dimensions.

Therefore, the result of this study indicated that teaching pre-service teachers with station rotation model in a BSCLE was found to be more effective in enhancing pre-service teachers critical thinking skills as compare to teaching with conventional means of learning. Similarly, the independent analysis of the sub-dimensions

measured by critical thinking based on teaching method also show higher mean score in experimental group as against control group.

VI. DISCUSSION

This section presents the discussion of results on critical thinking and teaching method based critical thinking assessment. The flow of the discussion will be based on the two research questions aimed to addressed by this research study. Thus, section 6.1 deal with answering research question one and section 6.2 answers research question 2.

A. Station Rotation Blended Learning Model in Blended Social Collaborative Learning Environment on Pre-service Teachers Critical Thinking

The present study tested the effectiveness of SRM-BSCLE to enhance critical thinking skills among year three pre-service teachers who take methods of teaching science course in Nigerian Universities. The findings of the difference of pre-service teachers critical thinking skill test for station rotation blended learning model in blended social collaborative learning environment (SRM-BSCLE) and conventional approach (CA) groups show a significant difference between the two learning approaches. This is because the overall critical thinking scores in critical thinking have shown a statistically significant difference in favor of group that was taught in SRM-BSCLE as against the CA. The findings of this study coincided with previous researches ([8] [33], 3[8], [47] Kim, Sharma, Land, & Fu,rlong, 2013; [72]).

In a study on comparison of two learning styles, the treatment group have achieved better performance in six of the seven dimensions of critical thinking as against traditional approach to learning that only achieved improvements in three dimensions [38]. This study's sample is almost equivalent to that of the present study with 110 participants in the two groups. Pre-service teachers critical thinking skills was enhanced as a result implementing microteaching in their pedagogical course. The treatment with microteaching has significantly enhanced pre-service teachers critical thinking skills as against traditional groups ([8]). Learners' progress in learners centered learning approach was significantly higher than traditional method. The application of leaners centered instruction enhance classroom activities, collaboration, critical thinking ([62]; [47], [72]). Furthermore, the findings of this study are in consistent with previous study by ([33], [48]). Comparably, a significant result was found between pre-service teacher in experimental and control groups in terms of their performance.

Thus, the findings of the present study aligned with the Arsal's, this might have connection the significant difference found in the scores of critical thinking skills after implementing the learning experience between experimental and control

groups. Interestingly, the intervention has yielded a positive outcome in which the treatment groups have obtained a higher score than that of conventional group. This implies that learning science method have in ether way improves pre-service teachers critical thinking.

Conversely, there are researches that show insignificant findings that contradict the results of the present study. In a study that that looked at two different learning modalities that involved experimental and conventional approach groups ([17], [85]), no significant difference between experimental and control groups. Hence, it is evident that no significant difference was found between two groups in the scores critical thinking test before conducting the intervention. The findings of the study revealed that insignificant results were found in the between groups in the achievement of scores in pre-service teachers critical thinking skills. There is no significant difference recorded in the critical thinking skills of learners between control and experimental group [17]. Learners in active learning environment did not improve in their critical thinking skills.

Additionally, all the findings of the five sub dimensions measured by critical thinking have shown a statistically significant difference between the results of SRM-BSCLE and CA. These findings were anticipated due to the fact that the overall results of the critical thinking test of intervention group has shown a positive difference against the conventional group. Even though Watson Glaser did not indicate that critical thinking according to the five sub dimensions, they only based their submission of measuring critical thinking base on the summations of the five-sub dimension, in this study, the researcher may wish to briefly explain the findings of the sub dimensions in GCT. This finding was in conformity with previous research that used similar questionnaire used in this study. For example, [38], pre-service teachers have excellently performed in six of the seven sub dimensions measured in critical thinking while the findings are not consistent with [30], her study revealed that it is only two of the five sub dimensions that pre-service teachers in experimental groups have excel. However, the overall findings of the study coincide with the present study's findings, in which it revealed that significant difference was discovered between experimental and control groups. This implies that, injection of the intervention on SRM-BSLCE has positively impacted in enhancing pre-service teachers critical thinking skills. This is not unconnected the inclusion of factors that was believed to enhance learners critical thinking.

According to previous researches, there are several factors that foster critical thinking among pre-service teacher ([9], [73], [74]). According to [74], a well-designed learning content guided by a constructivist learning environment influences learners' critical thinking. Also, in order to enhance pre-service teachers critical thinking, there is the need to strengthen the learning environment with teaching methods that are purely learners centered. This assertion was also conceived by

[73]. In this research work a well-designed learning environment was developed and employed based constructivist ideology. This learning environment may include: collaborative learning, active learning, small group learning, and blended learning. It is unanimously agreed that the learning environments such as blended learning [34], collaborative learning [25], social interaction [86], integration of technology on to teaching and learning [28] was believed to enhance learners critical thinking skills. The effectiveness of these pedagogical approaches was found to improve learner outcome and indeed their critical thinking skills.

Several studies have indicated the effectiveness of blended learning against traditional instruction ([20], [21], [65]). Blended learning has a multiple of benefits to a teacher education programme as compare to a learning environment that is based on conventional approach to learning [65]. A teaching module that was designed base on blended learning and with pedagogical approach that supported learners centered learning is believed to enhance pre-service teachers learning outcome [65]. A module was developed on blended learning by [78], has shown a high impact on a pedagogical classroom and it is found to be effective in enhancing pre-service teachers' performance. The current study has designed and developed a comprehensive learning environment that involves the needed pedagogical principles that encourage critical thinking as well as an application of blended learning model that has several learning modalities. It is believed that blended learning and pedagogical approach used in this study have assisted the researcher in providing resources needed for understanding the concept and as well reflect on effective behavior in study strategy [16]. The blended structure gives the participants in this study a deeper understanding of concepts and strategies that assist them in enhancing their critical thinking ability.

Furthermore, the socially mediated factors in this study have helped pre-service teachers managed to be learnt from peer interaction in which they are able to gain experience and construct meaning in concept they learned [16]. Pre-service teachers critical thinking has significantly improved through these dimensions of learning such as constructivist theory, collaborative learning, social interaction, and a blended learning. thus, technology integration in this study has helped several learning goals, it is evident that a constructivist approach on the other hand was found to be a learning strategy that enhance critical thinking [16]. Also, collaborative learning is a pedagogical approach that was found to improve pre-service teachers critical thinking skills [25], and blended learning blended learning model allow pre-service teachers to collaborate, interact, and participate in small group learning through several learning modalities [39]. These practices have a direct bearing on linking theory with practice in a more practical and applicable manner [20]. Teacher education should be engaged in relevant pedagogical principles that can enhance their critical thinking skills. This could be done with only viable and tangible learning platform that encourage critical thinking among pre-service teachers [21].

It has been observed that blended learning can improve learner critical thinking [81]. As a result, blended learning with online and constructivist learning approach have regularly improve critical thinking among learners [81]. Base on the findings of the present study, it is the researcher view point that the intervention on SRM-BSCLE did positively enhance pre-service service teachers critical thinking skills. This is due to the fact that the intervention received by the participants is built base on pedagogical techniques that was designed with focused on enhancing pre-service teachers critical thinking. In addition to the above claims, the findings of the have exhibited that participant have shown significant outcome in all the five sub dimensions measured by critical thinking test instruments used in this research study.

B. Station Rotation Model in Blended Social Collaborative Learning Environment on Pre-service Teachers in Teaching Method Based Critical Thinking

The results of the independent sample t-test revealed that there are significant differences in critical thinking skills among pre-service teachers in Station Rotation Blended Learning in Blended Social Collaborative Learning Environment (SRM-BSCLE) and Conventional Approach (CA) groups. There are statistically significant difference between critical thinking of SRM-BSCLE in all the five sub dimensions measured by teaching method based critical thinking, compared to CA. this results confirms the findings of ([41], [62], [82]).

{11] and [82]), found a significant difference in critical thinking between experimental and control groups. These findings complement the present study's findings focuses on enhancing pre-service teachers critical thinking skills. Furthermore, the present study's findings of the overall critical thinking scores before the intervention have indicated insignificant findings in SRM-BSCLE group and conventional group. Meanwhile, findings of the critical thinking scores after the intervention have shown that the intervention (SRM-BSCLE) obtained a significant improvement in pre-service teachers critical thinking skills.

In contrast to findings of the presents study, some research work has found an insignificant outcome in critical thinking between experimental and control groups ([15],; [44], [46], [85]). In a study on peer team learning has found similar findings with the preceding studies, in which no quantitative difference recorded before and after the intervention between treatment and control group [79]. The findings of the five sub dimensions of critical thinking indicated that there no statistically significant difference was found among the five sub scales of critical thinking of learners. More so, findings of the scores before conducting the intervention has shown that performance of experimental groups is higher than that of control group, this indicates that the former was advanced in critical thinking skills as compare to the latter [15], as discussed in chapter one, informing the research problem

statement and the conceptual framework, that constructivist approach to learning couple with integration of technology in to teaching and learning may enhance pre-service teachers critical thinking skills. Further researchers also negate the result with the present study, [85], suggested that there is no significant difference was noticed between experimental and control groups. This shows that learners in both groups after the intervention have not improve in their critical thinking skills [85].

An insignificant result between the scores of experimental and control groups was found [46], base on the findings, it has been concluded that the groups were found to be equal before and after the intervention took place. No difference in terms of critical thinking skills in an online learning environment in pre-test and post-test results [44].

However, the pre-service teachers who participated in the SRM-BSCLE have demonstrated a high critical thinking skill as compare to CA group. The findings of the study may serve as the justification to broaden the new horizon to learning approach that can create an effective teaching and learning. This learning environment is efficient in terms of helping to know the systematic independent application of various forms of teaching. Another very interesting fact to support the above claim is that the participants in the experimental group have gained skills such as learning collaboratively, group learning, social interaction among peers, and online learning.

Collaboration in a blended learning environment help explain how learners are improving in their learning outcome [29]. A number of study was conducted on effectiveness of blended learning environment, among which are the ones that examines the effect of critical thinking ([14], [35], [36] [52]). Furthermore, blended learning environment and online learning help improve pre-service teachers critical thinking [52] Blended learning in teacher education encourages pre-service teachers' collaborative, social interaction, and critical thinking ([10]). [35], in a study on the use of social media on academic practice enhances their critical thinking. In the present study an application of different teaching approach as well as technology integration through blended learning environment together with pedagogical approach have improve pre-service teachers critical thinking skills.

Blended learning environment was found to be effective as compare to traditional approach [50]. The findings of their study have revealed that teaching with blended model was found to contribute to learners critical thinking when it was compare to a learning model that was built in traditional approach [50]. Learners in a blended learning model have exhibited a high performance as compare to other learning settings [84]. The findings of this study suggest that blended learning environment enhance learners' performance. Also, blended learning instruction has been proven to contribute in enhancing critical thinking among pre-service teachers [57].

Technology is found enhance classroom is found to be more effective compare to traditional instruction [32]. A significant difference improvement was obtained between treatment and traditional instruction. The findings suggest that digital storytelling and visual memory of both groups have improved, however, the average scores of experimental group is greater degree [73]. A jigsaw technique was used to investigate the effects of laboratory approach and confirmatory laboratory approach among pre-service teacher. The findings of this study show a significant difference between the two group [45]. Studies on the effectiveness of blended learning have shown meaningful results.

The study was implemented through a station rotation blended learning model in a blended social collaborative environment to enhance pre-service teachers critical thinking. The assessment was conducted before and after the intervention. The learning environment constitute in this study, the intervention was only given to pre-service teachers in experimental group. The pedagogical approach has critically emphasized in learning process, which in turn was expected to derive critical thinking of pre-service teacher. The researcher developed a learning environment that was filled with pedagogical principles that aids critical thinking.

The empirical findings in this study have provided a new pedagogical approach namely, SRM-BSCLE and the findings shows that it is more effective in gaining critical thinking skills by pre-service teachers as compare to conventional approach. Pre-service teacher who have undergone training through SRM-SCLE are enhance in their critical thinking skills. Hence, the participant in the SRM-BSCLE have a deeper understanding of the concept as well as they have easily acquired the fundamentals of how to relate what they learned in the process of the intervention. They also gained astute knowledge of the most prioritized teaching methods in teaching science and its application in their daily life workplace.

Subsequently, in this study, the attention received by experimental group on SRM-BSLCE to enhance pre-service teachers critical thinking skills. Pre-service teachers who have been subjected to SSRM-BSCLE are exposed to several learning modalities that might assist them in their future career as prospective teachers in their respective localities. They are able to work in a group, collaborate, interacting with their peers. Pre-service teacher has also gained experience of handling of computer and the internet as well as how to identify and download relevant video, materials, and infographics to aid their classroom instruction. These factors had helped pre-service teachers to enhance their critical thinking.

VII. CONCLUSION

The rationale of this research study was to examine the application of station rotation model in blended social collaborative learning environment to enhance critical thinking among pre-service teachers. the learning environment on SRM-BSCLE

was found to enhanced participants critical thinking skills in the tow instrument used to measure their critical thinking. Therefore, it is paramount that the learning environment should be imbibed by educators to enhance learners critical thinking at all levels of education. This could be achieved through the application of instructional approach that is believed to promote critical thinking: collaborative learning, blended learning, zone of proximal development. The results independent sample t-test revealed a significant difference between experimental and control groups in both general critical thinking and teaching method related critical thinking. This implies that pre-service teacher in experimental group has score high in the post test result as compare to the control group.

Thus, based on the learning environment of this study, the SRM-BSCLE combines activity base learning, collaboration between learners, small group learning, active teacher engagement, and the blended instruction has significantly help encouraged pre-service teachers to enhance their critical thinking. Thus, these learning environments which comprise of blended learning, collaborative learning, and social interaction. Furthermore, it shows that the learning environment on SRM-BSCLE possessed critical thinking skills in all the five constructs measured by general critical thinking and four of the five constructs in teaching method related critical thinking. Therefore, it is recommended that further studies should employed an explicit infusion critical thinking approach in learning materials of methods of teaching science where critical thinking should serve as a critical focus as against the used immersion approach that allows the adoption of pedagogical approach that has a direct bearing to enhance critical thinking.

Acknowledgment

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