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Abstract

This study examined pre-service teachers' views on how the station rotation model learning environment enhances their critical thinking skills. This research studied how a learning environment coupled with blended learning and a social learning environment improves teachers' performance. The participants were 54 pre-service teachers who took part in a quasi-experimental study; the participants received intervention on a station rotation model with a blended social learning environment (SRM-BSCLE). Face-to-face interview data were collected from six (6) pre-service teachers selected based on high, medium, and low-performance criteria. The obtained data were analyzed using thematic analysis; the qualitative data indicated that pre-service teachers' views on the learning environment comprised of station rotation model, collaborative learning, blended learning, and Vygotsky's social interaction Zone of Proximal Teacher Development (ZPTD). The study shows that the six pre-service teachers who took part in the interview were able to identify the theoretical components of the research objectives in this research. This includes collaborative learning, blended learning, station rotation model, constructivist approach to teaching, and teaching aids. Thus, the findings obtained from this study were discussed within the frame of the

relevant literature. There made on designing a learning environment that can enhance the critical thinking skills of pre-service teachers.

Keywords: Collaborative Learning, Blended Learning, Station Rotation Model, Constructivist Approach to Teaching, Teaching Aids, Zone of Proximal Teacher Development, Pre-Service Teachers

Introduction

The station rotation blended learning model has been one of the relevant models for teaching and learning for online learning and blended classroom. It allows instructors to provide instruction within classroom teaching with an innovative pedagogy that allows a collaborative and social learning environment. It is, however, believed that the station rotation blended learning model alone may not enhance pre-service teachers' critical thinking. Choosing the best technology by a well-trained and professional teacher may not produce successful instruction. A proper teaching approach coupled with the best technology may yield a positive learning outcome (MacKinnon, 2002). Therefore, it is necessary to include a learning approach that encourages critical thinking. Collaborative learning enhances critical thinking among learners (Gokhale, 1995; Mandusic & Blaskovic, 2015; Styron, 2014). There is a need to look at the phenomenon from the angle of the blended social, collaborative learning environment. Consequently, to be specific in developing and testing a framework: Blended Social Collaborative Learning Environment (BSCLE), to enhance pre-service teachers' critical skills, this study might be unique and contribute to the existing tones of literature.

The station rotation model is how a given course or subject students rotate on a fixed schedule or at the teacher's discretion. The students rotate between classroom-based learning modalities (Staker & Horn, 2012). The rotation might include one station is online, learning. At the same time, the other groups in the class might be subjected to either small group or full-class instruction, group projects, individual tutoring, or paper and pencil assignment. In this form of the rotational model, student rotates through all the rotation but not necessarily in their custom schedule. For instance, in a particular set of groups is online for a certain period, it would shift to be replaced by those in a group project or small group. The rotation will go on and on to make sure all the groups are fairly represented (Staker & Horn, 2012). The figure below depicts the station rotation model.

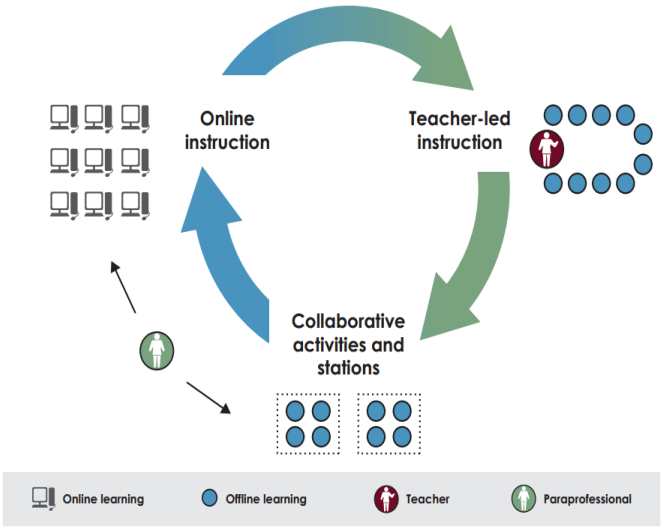

Figure 1: Station Rotation Model: Source (Staker & Horn, 2012)

According to Suana et al (2019), several blended learning models remain valid in applying classroom instruction depending on the situation, time, and resources at one's disposal. For example, flipped model requires the internet to support learning from within and outside the classroom through face to face, and the online learning and lab rotation model demands that computers and other tools needed for the class setup require cost implications. However, the blended learning model that supported this study is the station rotation model that allows for applying several learning modalities depending on the teacher's discretion. Thus, the adoption and application of the station rotation model resulting from overcrowded classrooms coupled with an infrastructural deficit in Nigerian universities have prompted a blended learning model that may require minimal expenses that could generate a high impact. The blended learning model is cheaper and accessible to set up because it requires only one station with a computer, and the rest should be constituted of different learning abnormalities.

In this study, the researcher adopted station rotation blended learning (SRM) due to its effectiveness, and it suits the context of the research as claimed in the problem statement. That the lack of critical thinking skills among pre-service teachers in Nigerian Universities is attributed to poor infrastructure, lack of qualified teachers, and the continuous application of conventional teaching approaches (Daouk et al., 2016; Umoh & Akpan, 2014; Wartono et al., 2018). The need to design a leading environment that suit accommodates the station rotation blended social, collaborative learning environment (SRM BSCLE).

Staker & Horn (2012) defined blended learning as an instructional strategy in which learners part through online delivery of instruction and content with some elements of control over the place, time, and pace. Blended learning includes computer technology and the fusion of online or offline activities and material for instruction (Tomlinson & Whittaker, 2013). This definition entails that blended learning encompasses all types of learning, including traditional face-to-face and technology-inclined instructions. Blended Learning could be seen as a mixture of different forms of learning that includes face-to-face learning with computer-mediated activities (Omiola, 2012); the term is also defined as a face-to-face facilitator of a computer-mediated instructor who encourages collaboration among learners. Regha (2015) sees blended learning as a combination of the most efficient teaching and learning activities of the online environment and traditional face-to-face classroom. Akinbobola and Asagha (2013), blended learning is a form of an education strategy that combines computer-mediated activities and face-to-face instruction.

The implementation of the station rotation model involves the rotation of learning modalities across the classroom through all the stations. The model requires the teacher to work with small groups as well as it requires little time to adjust the teacher, to design the learning environment. It also facilitates project-based learning (Horn & Staker, 2014; Truitt, 2016; Walne, 2012; Staker & Horn, 2012). This model has its flaws; for instance, the teacher who is to carry out this model should possess specific skills acquisition on how to employ the teaching. Similarly, online learning organizations should be made simple for their users.

This blended learning model allows learners to operate on a fixed schedule or at the teacher's discretion, and learners may change their learning skills. Station rotation is the best for teachers who are migrating from the traditional form of teaching to blended learning. The model teaches a series of learning activities that promote effective instruction. Such teaching modalities may include learning in small groups, collaborative learning, individual tutorials, and paper and pencil assignments. Thus, these learning activities promote a student-centered approach to learning and are applicable in the teacher education program. Contemporary,

some universities have used neuroimaging and physiological tools to study the education process and the student responses to the educational process (Alsharif et al., 2021b, 2021e, 2021g, 2022, 2022).

To support pre-service teachers to enhance their critical thinking skills, a learning environment is specifically designed using blended learning, a station rotation model, collaborative learning, the zone of proximal development (ZPD), and social interaction. In the learning environment, the station rotation model comprises different learning modalities to accommodate different learning modes to engage other groups of pre-service teachers simultaneously. The reason for using the station rotation model is that it provides the basis for addressing several learning modalities in one shot. It requires less effort for a teacher to understand and master the application of the model. Additionally, this technique contains a variety of instructional media for preservice teachers to learn through different learning strategies by interacting with their peers and teachers (ZPD). Also, the learning environment provides room for group learning, collaboration, working with further contact, materials, and feedback from a teacher (Sun & Gao, 2017).

More importantly, the application of a blended learning model coupled with pedagogical strategies is believed to enhance 21st-century skills for pre-service teachers (Annamalai, 2018; O'Bannon, Lubke, Beard, & Britt, 2011), including collaborative learning (Ben-zvi, 2007; Hong, Lin, Sing, Hung, & Zhang, 2019; Malik et al., 2018), blended learning (Gasparic & Pecar, 2016; Kong, 2015; Pellas & Boumpa, 2017), social learning (Guzer & Caner, 2014; Smit, Rietz, & Kreis, 2018), zone of proximal development (Chaiklin, 2002; Fernandez et al., 2001; Lee et al., 2016; Abuhassna & Yahaya, 2018; Abuhassna et al., 2020b, Abuhassna et al., 2020°; Abuhassna & Awae, 2021; Abuhassna et al., 2022a, Abuhassna et al., 2022b). Similarly, studies indicate means of developing a learning environment with multiple pedagogical approaches to enhance critical thinking among pre-service teachers (Akinoğlu & Karsantik, 2016; Østergaard, 2018; Simpson, 2016; Zhou et al., 2017). Altogether, pedagogical approaches like collaborative learning, Blended learning, and social interaction with ZPTD provide a flexible possibility for creating an environment for enhancing pre-service teachers' critical thinking skills.

Methods

The qualitative data analysis was conducted on a structured interview on the research question (How do pre-service teachers' views on enhancing critical thinking through station rotation model with blended social learning environment improve critical thinking skills for learning?). The interview data were analyzed with thematic analysis techniques. Thematic analysis is one of the qualitative research techniques used to analyze text data, based on selecting the keywords expressed by participants in an interview related to the research question (station rotation, collaborative learning, and blended learning). A thematic approach captures the most important data collected from participants concerning the research question in a study (Braun & Clarke, 2006). This study analyzed a theme using transcription, encoding, describing, analyzing, and reporting data.

Thematic Analysis

The thematic analysis involves identifying, analyzing, and reporting patterns with data. This implies that thematic analysis captures an essential aspect of data about the research question. In this research, one of the two types of thematic analysis has guided the conduct of this section of the study. The researcher employed theoretical or analytical interest in thematic analysis to allow a detailed description of the data and give a more detailed analysis

of the data obtained from the interview. Based on the types of thematic analysis, the researcher further employed the semantic level of thematic analysis. A semantic thematic approach was based on the surface meaning of the data collected on the Station Rotation Blended Learning Model in a Blended Social Collaborative Learning Environment based on what research participants have said. The process helps examine the underlying assumption, ideas, and interpretations that assist in shaping the data collected during the interview.

To answer the research question, the researcher adopted Braun and Clark's (2006) framework for thematic analysis to identify themes for the study. The process includes familiarizing data, generating initial codes, searching for themes, reviewing the obtained theme, defining the themes, reviewing themes, and report writing.

Phase One: Familiarization of Data

The familiarization of data was conducted through the transcription of the interview data. This was performed by fully understanding the responses of the six audio files of the interview. The researcher has carefully listened severally to these audios before transcribing the final data transcription interview. The process of data transcription was conducted with Microsoft Office Word. Secondly, the transcribed data helped the researcher to relate with his supervisor to solicit advice on how to code and thematic development for the data to become proper. The data transcription was subjected to manual coding alongside guiding principles laid down by the framework for thematic analysis (Braun & Clarke, 2006). Furthermore, an expert validated the transcript before subjecting it to coding and thematic development.

Phase Two: Generating Initial Code

This process involved reducing the numerous data into manageable units. The researcher employed theoretical thematic analysis to align with the research question. Therefore, the theoretical constructs that guided the research question answered by this research work are collaborative learning, a social constructivist approach to education, blended learning, and station rotation. Table 1 below shows the initial code generation.

Table 1

Generating Code

Code	Construct	Description
CL	Collaborative Learning	Grouping, relating with peers, interaction, socialization.
BL	Blended Learning	Face-to-face instruction, online learning.
SRM	Station Rotation Model	Online learning, Video instruction, individual tutoring, group collaboration.
TM	Teaching Method	Learning by Doing, teacher as facilitator, collaborative learning, small group instruction.
TA	Teaching Aids	Apparatus that aids effective teaching and learning.

Phase Three: Theme Development

In this phase, the researcher examines the codes that directly correlate to the already established or identified codes generated from the interview question, as the pre-service teacher stated in the interview session. At the end of the exercise, it was gathered that the developed themes were organized to say something meaningful about the research question. (The preliminary themes that were extracted from the generated codes). Table 2 shows the example of theme development. Table 2 shows the preliminary themes that were extracted from the generated codes.

Table 2
Preliminary Themes

Theme: Social Constructivist Approach to Learning	**Theme: Collaborative Learning**	**Theme: Blended Learning**
Codes: a scientific approach to teaching A constructivist approach to learning effective teaching approach effective learning outcome teaching activities a scientific method of teaching. multiple approaches to learning The nature of training and pedagogical process teaching scientific method there are several components of the teaching method We were given a constructivist approach to learning with active teaching supervision excessive training and systemic approach appropriate teaching strategies	**Codes**: instructor has used a combination of a collaborative approach to learning collaboration and active participation collaborative groups to corporate with our peers in learning grouping with our colleagues Collaboration learning in which our teacher divides as into groups Active participation Confidence-building between the teacher and the learners active learning engagement group learning computer instruction teacher group us into two groups of six, each group plays a specific role at a time work in a collaborative manner working in collaborative groups	**Codes**: face to face and computer instruction rotate kind of learning shift from one form of learning strategy to the other blended structure of learning was fully involved in teaching the in our scientific method class computer instruction constant rotation in the learning process Blended learning through rotation and shifts in the learning process assigned to rotate on a computer learned based on collaboration couple rigorous face-to-face teacher's guidance computer and screen-recorded instruction working with computers A blended instruction

Theme: Teaching Aids	**Theme: Teaching Method**	
Codes: use of scientific tools Attending class with numerous activities teaching and strategies required instructional aids A classroom with adequate resources instructional facilities accurate methods and apparatus for teaching science by our lecturer use different methods and apparatus learning resources, instructional aids while teaching sciences teaching aids and apparatus application of instructional aids instructional aids task, material, and method use of chemicals and a mixture of tissue manipulation of instructional and learning aids appropriate teaching aids teaching aid application tools and gadgets that are required for science teaching. laboratory indeed was also part of science teaching required teaching method combination of teaching method	**Codes**: a variety of several methods adopt the appropriate teaching method demonstration method, project method, mastery learning, laboratory approach, concept mapping, task-based learning, collaborative learning, corporative learning, discovery method, experimental learning, inductive and deductive method I knew several methods of teaching application of various methods of teaching used laboratory approach Task-based learning Problem-solving interdependently under the collaborative method project base method, demonstration method, collaboration method, grouping excursion, practical demonstration	

Phase Four: Review Themes

Table 3 shows how the researchers review, modify and develop the preliminary themes identified earlier in phase three. This allows the filtering of valuable and relevant data

needed for the study. Thus, this was achieved by organizing data by applying Microsoft office word/excel by color-coding each associated with others.

Table 3
Reviewed Themes

Theme: Blended Learning Environment	**Theme: Collaborative Learning Environment**	**Theme: Components of teaching**	**Theme: Teaching Apparatus**
Sub-themes: Blended Learning	**Sub-themes: Collaborative Leaning:**	**Sub-themes: Methods of teaching**	**Sub-themes: Teaching Aids**
A blended instruction Individual and group basis The blended nature of the class gave me some confidence. Online learning blended teaching and learning Blended learning with both face-to-face instruction Face to face instruction and computer-supported instruction The blended structure of education was fully involved in teaching the in our scientific method class Sub-themes: station rotation model Working with computers use the computer collaboratively	Collaboration and active participation Collaborative groups to corporate with our peers in learning Collaboration learning in which our teacher divides as into the group Active participation Active participation collaborative learning (groping) Collaborative instruction active learning engagement Active participation of both teacher and his students The instructor used a combination of a collaborative approach to learning Active teaching guidance handle or tackle the problem	The scientific method of teaching. Teaching scientific method Student-centered learning Solving problem Engaging us in fieldwork or practical work Practical Demonstration Practical work And visitation of the industrial side for physical and Learners centered approach to learning, Directed learning in which the teacher guides us in Handle or tackle the problem	Use of scientific tools Attending class with numerous activities Teaching and strategies required instructional aids A classroom with adequate resources instructional facilities Accurate methods and apparatus for teaching science by our lecturer Use different methods and apparatus learning resources, Instructional aids while teaching sciences teaching aids and apparatus Application of instructional aids

Between one group Lecture's guidance with computer and video recorded instructions online learning Couple with video learning Video and online learning browsing through the internet to gather resources Face to face and computer instruction rotate kind of learning shift from one form of learning strategy to the other Computer instruction Constant rotation in the learning process Blended learning through rotation and shifts in the learning process assigned to rotate on a computer Learned based on collaboration couple rigorous face-to-face teacher's guidance That provides all the trainees with a high level of activities varieties of assignment Sub-themes: Screencast video	using various method active teacher engagement Active participation of both teacher and his students Active teacher engagement active engagement of teacher Instruction is more of task giving with active supervision on the individual group basis multiple leaning task Sub-themes: Collaborative Group: Grouping with our colleagues Confidence building between the teacher and the learners Group learning computer instruction The teacher grouped them into a group of six The group plays a specific role at a time Work in a collaborative manner Working in collaborative groups where students were grouped with	A learner-centered approach that gives room to all conditions for learning A scientific approach to learning Not all topics are dear to be taught in the laboratory. Discovery of project, Task-based learning Experimental learning Experimental learning Demonstration method, Project method, mastery learning, laboratory approach, concept mapping, task-based learning, Collaborative learning, Corporative learning, Discovery method, experimental learning,	Instructional aids task, material, and method Use of chemicals and mixture of tissue Manipulation of instructional and teaching aids Appropriate teaching aids Teaching aid application Tools and gadgets that are required for science teaching. laboratory indeed was also part of science teaching required teaching method Combination of teaching methods

Video instruction, collaborative group, activities through computer Sometimes watch videos on teaching methods and effective use of science laboratories Computer and screen-recorded instruction	the different tasks given a total number of 6 in a group All the group play their roles differently working together Attention was provided to all members either individually or as a group. Active learning engagement	Inductive and deductive method I knew several methods of teaching.	

Phase Five: Define Theoretical Themes

This phase deals with defining the themes as they were reviewed in the previous stage; in this process, five themes emerged. Below is the presentation of the model that demonstrates the themes of blended learning and the social constructivist approach to learning. Based on the thematic analysis results, it is discovered that the blended learning and station rotation model as identified by the respondent had helped them achieve learning through the learning environment. Also, in the theme map, it has been ascribed that the participants have indicated the presence of collaborative learning, a teaching method that has a direct bearing on learners centered approach to teaching, as well as the influence of several education aids in the learning environment had significantly influenced the participants to achieved learning. Evidence shows that the learning environment that comprises blende instruction combined with a constructivist approach enhances learning outcomes. Figure 1: below illustrate the theme from the participants' responses.

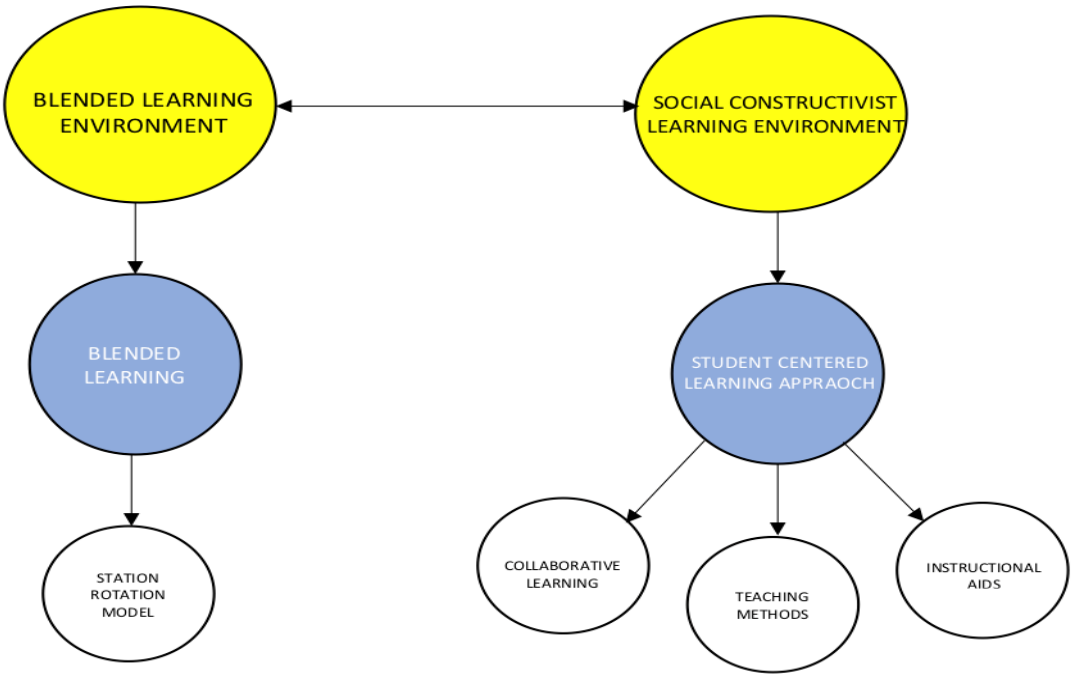

Figure 1: Theme Map

A manual check has shown that the themes are accurate to the analysis. To improve the validity, reliability, and trustworthiness of the thematic analysis results, the researcher has double-checked the participants' transcripts and confirmed the theme since he is familiar with the content of the transcript data. Furthermore, the researcher seeks his supervisors' advice on whether the emerged theme is congruent with the research question this section aims to address. Then the researchers went further to engage experts as to whether themes have a valid correlation with the variables covered by the research question; they affirmed the accuracy of the coding with the research question.

Expert Review

Research question nine deployed experts' opinions in supplementing the quantitative and qualitative data triangulation to develop a framework for enhancing critical thinking among pre-service teachers in developing a framework using a consensus of experts' opinions (Nambisan et al., 1999). The framework, namely blended social, collaborative learning environment (BSCLE), was opinionated by four experts that were drawn for educational technology (2), curriculum expert (1), and a subject matter specialist (1). The expert provided valid comments and suggestions to improve. For example, the curriculum expert and the subject matter specialist approved the framework with corrections in merging the blended learning and station rotation model and allowing teaching aids variables to stand alone. The two educational technologists suggest making a mild correction and approve the framework should be concise and clear. Similarly, one of them indicates that the framework should provide a detailed description to guide instructors on how to implement the framework. All the experts' feedback was considered in improving the framework to look in its present form.

Table 4
Expert Review

1.	Qualitative	Interview	Theme Analysis	Data Transcription, Analyzing, Encoding, and Description, reporting
2.	Expert review	Interview	Expert opinion	Expert consensus opinion

Results

How Station Rotation Model with Blended Social Learning Environment (SRM-BSCLE) Enhance Critical Thinking Skills for Pre-Service Teachers'

The research participants were taught methods of teaching science using SRM-BSCLE. This study was conducted based on pre-test and post-test testing of pre-service teachers' critical thinking. After which, six participants were selected from the experimental group to interview with them. The selection was based on the three categories of low, high, and average achievement scores in pre and post-test. After fulfilling all the requirements for conducting the interview session, the interview session was granted at the faculty of education's board meeting room. The session was implemented by recording the voices of the six participants independently with an audio recording device, after which the data was transcribed and manually analyzed (Braun & Clarke, 2006). The interview was individually conducted immediately after completing the six-week intervention on the station rotation model in a blended collaborative learning environment with the participants in the experimental group.

Kolo's Response to Interview Questions

Kolo participated in the station rotation model in a group blended social, collaborative learning environment. She plays the role of a group moderator in her collaborative group. She got the second-highest score in her pre-test and post-test scores.

The interview aims to examine pre-service teachers' views on the learning environment to support and explain the quantitative aspects' findings and formulate a proposed framework for the blended social, collaborative learning environment. Given that, the researcher will explicitly define the response by Kolo and later summarize and later provide the summaries of the remaining participants. This is due to the management of space and being concise on issues. The researcher hopes that the first fully explained interview session will provide helpful insight into the other participants' remaining responses. Thus, there exist six participants in the interview section, namely, Kolo, Modu, Mele, Shehuram, Ali, and Talala. To begin with, Kolo whose response to the interview question will be explained in detail. Below are the extracts from the questions posted to Kolo in the cause of the interview:

Q1: *Do you think understanding the teaching science method improves after attending this course? If so, how? And if it is not, why?*

K1: *This course and its approaches have made me understand that there are several ways of teaching science through the existing teaching methodologies and scientific tools.*

In Q1, Kolo explained her level of understanding of methods of science method by stipulating that while attending the class, she can understand that there are several means of teaching science and the tools involved in the teaching of science. Based on this explanation, it is deduced that Kolo could be able to trace that there are applied teaching methods involved in the learning environment. Therefore, the researcher concludes that since the learning environment was designed based on a constructivist approach, the participant mentioned several of these approaches and instructional aids that define some of the components of the learning environment.

Q2: *Are there components of teaching methods? If so, what are they?*
K2: *Many! If allowed, I can list those teaching method components that I know are best among those considered to be teaching science. For example, our instructor has used a combination of a collaborative approach to learning and face-to-face and computer instruction. Above all, the instruction is more of task giving with active supervision on a group to an individual basis. We have rotated a learning shift from one form of learning strategy to the other. Perhaps this is the first-ever multiple learning task that I have undergone in one instruction, and I appreciate it with all sense of sincerity.*

Additionally, in Q2, where the participant was asked to explain if there are components of teaching in the learning environment, Kolo was able to list out several of the components of teaching. Firstly, Kolo indirectly mentioned the existence of blended learning in the learning environment. She states that there is face-to-face and online instruction. She further explained that there are tasks and active teacher supervision on a group and individual basis. This assertion supports the claims that state the existence of a Zone of Proximal Development (ZPD), collaborative learning, and teacher's active guidance for developing personal understanding to help facilitate teaching and learning. In this regard, it can be deduced that there are elements of social interaction, collaboration, and station rotation in the learning environment. Furthermore, Kolo has explicitly mentioned the station rotation Model by stating that they were allowed to rotate across several different stations.

Q3: *If you were asked to analyze the scientific teaching method, how would you do so?*
K3: *Scientific approach to learning focuses not only on science teaching alone, but it covers many more aspects of education and human development. For example, not all methods are appropriate for a specific topic, and not all topics are there to be taught in the laboratory—a scientific approach to learning deals with a technique such as discovering a project. Task-based and experimental learning, sometimes practical learning, is also valuable; otherwise, the reverse may be the case. This is not all; many tools and gadgets are required for science teaching. Laboratory indeed was also part of science teaching.*

In response to Q3, Kolo analyzed the teaching of science method by differentiating between the appropriateness and inappropriateness of applying a particular approach to a specific topic in teaching science. An example was cited concerning not all teaching methods are appropriate in teaching a laboratory to students. The participant stated the mentioned proper methods of teaching science. For example, the discovery method and experimental

approach were some of the appropriate methods of teaching science mentioned by Kolo. Similarly, Kolo has further related that there are teaching aids used in the learning environment. in this section, the researcher concludes that Kolo can spell out the existence of both teaching method (TM) and teaching Aids (TA) in the learning environment.

Q4: *Can you think of a situation in a classroom where you felt that your ability to teach scientific methods was enhanced after attending this course?*
K4: *This is obvious that my ability to teach science students cannot match my previous experience. Attending class with numerous activities helped me realize that the scientific approach to teaching does not only stop at a few methods as we know before. Instead, there are many teaching strategies to be deployed while teaching science.*

Based on the response to the Q4, Kolo explained that her ability was enhanced compared to her former condition before participating in this intervention. This indicates that the learning environment has significantly improved her learning. The participant further revealed that the learning environment was well-coordinated and full of instructional activities that helped her realize the concept taught. These findings indicate that the learning environment enhanced their learning outcome.

Q5. *Can you think of a situation in a classroom setting in which you felt that your ability to teach effectively was not enhanced after attending this course?*
K5: *Absolutely, not because we are fully equipped with what it takes to improve our ability to teach a scientific approach. Consider us semiprofessional teachers that can effectively instruct their class with the required teaching method only couple with the required instructional aids.*

When asked whether her ability was not enhanced, Kolo was swift to reject and affirm that her knowledge was enhanced by the well-designed learning environment fitted with the required teaching and learning faculties.

Q6 *Does the learning environment provide the avenue for the ideal condition to teach pre-service teachers to learn methods of teaching science?*
K6: *Wonderful! A classroom with adequate resources is needed to learn in any circumstances. We were fully engaged through a constructivist approach to learning. Our lecturer has used a combination of teaching methods that makes us understand the art of teaching according to our learning style, which encompasses much more than expected. Perhaps, we are proud to associate ourselves by attending EDU301D as a course. Thus, the class is full of human collaboration and active participation from all angles.*

In response to whether the learning environment offers ideal settings for learning. Kolo outlined some of the essential components that make up the learning environment. for example, she stipulates the existence of adequate resources, a constructivist approach, and active teacher guidance throughout the learning process. Thus, given the above, the researcher deduced that Kolo was able to highlight the constructivist approach, collaborative learning, active teacher guidance (ZPD), and teaching aids.

Q7: *Can you freely comment on whether there is a need for improvement or otherwise regarding teaching pre-service teachers to learn methods of teaching science?*

K7: *Well! It is paramount to have adequate instructional facilities and a practical teaching approach employed in the just concluded course we attended. Pre-service teachers in Unimaid should be taught through a similar technique for effective learning outcomes. The need for relevant teaching activities to emulate such practices enhances the teaching profession throughout the country.*

When asked to comment on the need for improvement or otherwise freely, Kolo could relate that a learning environment with adequate resources like the present one should be employed throughout the country to encourage professionalism in teaching and learning. This indicates that the intervention had impressed the participant to suggest implementing this learning environment in a national outlook.

Q8: *To what extent has your teacher encouraged you to teach the required teaching method in teaching scientific method? Explain*
K8; *The teacher's attitude and the classroom setup are enough to tell that the teacher is professional enough to know that his body language reveals that he encourages us to learn the scientific teaching method.*

Regarding answering Q8, the instructor encourages them to learn. Kolo was able to positively comment on the teacher's attitude and the classroom setup., which was professionally designed to promote learning. This assertion directly links to portraying the characteristics of a good teacher. Similarly, this comment represents the active role in promoting Vygotsky's zone of proximal development.

Q9: *Do you acknowledge that there is a good practice of teaching the scientific method after enrolling in this class?*
K9: *After attending this course, my conception of the scientific method is tremendous. The teacher's experience, coupled with the multiple learning approaches, had enhanced learning capacity.*

Kolo was able to state that by enrolling in teaching science classes, she can experience several approaches to learning. In this regard, the assertion complements the outcome of the main study that deals with the experimental procedure. A significant difference was found between the general critical thinking test and the teaching method-related critical thinking test.

In her response to the interview questions, Kolo has clearly stated the theoretical variable identified as elements that constitute the learning environment created by this study to enhance pre-service teacher critical thinking. In the interview session with the participant, it is believed that learner response may be correlated with the findings of the quantitative aspect that shows a significant difference between the control and experimental group, whereby the experimental groups' mean score is found to be higher than of control group. The experimental group was taught in a learning environment that combines blended learning, collaborative learning, a station rotation model, a student-centered teaching method, and several teaching aids. These components of teaching enhance learners' critical thinking skills. Based on the findings from the response by kolo, Table 5 indicates the summary of findings that represent the research question that the interview portion tries to answer.

Table 5
Summary of Kolo's Response to Interview Questions.

Theme	Response
Blended learning	Face to face and computer instruction and above all the instruction is more of task giving with active supervision on the individual group basis.
Collaborative Learning	Our instructor has used a combination of a collaborative approach to learning,
Station Rotation Model	We have rotated a learning shift from one form of learning strategy to the other. Perhaps this is the first-ever multiple learning task that I have undergone in one single instruction, and I appreciate it with all sense of sincerity.
Teaching Methods	our lecturer has used a combination of teaching methods that makes us learn the art of teaching according to our learning style, which encompasses much more than we expect
Teaching Aids	Conclusion: There are lots of tools and gadgets required for science teaching. Laboratory indeed was also part of science teaching.

The interview findings show that after receiving the intervention through the station rotation blended learning model in BSCLE, Kolo has stated that the learning environment had improved her learning prowess. Similarly, the interview findings show that Kolo could say the components learning environment used in this study. The data analysis indicates that Kolo has improved their critical thinking skills. This is because the participant in the interview session has portrayed pedagogical strategies that were proven to enhance critical thinking. Though there is no direct instruction on critical thinking as a course among the pre-service teachers in the intervention on SRM-BSCLE, the techniques and strategies adopted for the research were proven to enhance learners' critical thinking. The learning environment has a significant impact on enhancing pre-service teachers' critical thinking skills. This is because the participant has indicated all the five (5) identified themes that were earlier projected to improve their critical thinking. In addition, the findings confirm the quantitative aspect results where the control and experimental results show a significant difference between the critical thinking of pre-service teachers in favor of the experimental group.

Mele's Response to Interview Questions

Mele participated in the station rotation model in a group blended social, collaborative learning environment. He served as an envoy in his collaborative group. He got a medium score in the scores of both pre-test and post-test.

The interview aims to examine pre-service teachers' views of the learning environment on SRM-BSCLE. Based on the response to the interview questions, the researcher formulates a framework for enhancing pre-service teacher critical thinking skills. This section seeks to

address research question 8, in which pre-service teachers view the learning environment to help explain the outcome of the quantitative aspect of the present study. In this section, Mele's response to the interview question will be presented in detail, and later the summary of the results will be presented in Table 6.

Q1: *Do you think understanding the teaching science method improves after attending this course? If so, how? And if it is not, why?*
M2: *Absolutely, yes! The nature of the training and pedagogical process we received is very intensive. We learned tremendously that my understanding of teaching scientific methods has significantly improved after attending this course. Our lecturer introduced us to many accurate methods and apparatus for teaching science. For instance, the approach adopted in teaching us is unprecedented in such a way that a blended structure of learning was fully involved in teaching the in our scientific method class. We are guided on all the processes applied in scientific solutions to problems.*
Q2: *Are there components of teaching methods? If so, what are they?*
M2: *Indeed, there are several components of the teaching method in the instruction we received. This is because our instruction is so well vast to learning that we were given a constructivist approach to learning with active teaching supervision; we were also divided into collaborative groups to corporate with our peers in learning. Moreover, computer instruction coupled with operational teaching guidance has made us well informed about the teaching and understanding of the scientific method.*
Q3: *What does the scientific teaching method in teacher education mean to you?*
M3: *My role as a teacher will essentially be to transfer those methodology and experiences obtained from attending this course. Cause I learn how, when, and where to use different methods and apparatus to apply in my classroom, I also accept specific experiences on how to handle or tackle problems. Perhaps, I understand the tenet of helping my student achieve their goal.*
Q4: *Does the learning environment provide the avenue for the ideal condition to teach pre-service teachers to learn methods of teaching science?*
M4: *Positive! The environment within which we learned has been loaded with abundant resources in which we were bombarded with grouping with our colleagues, many learning resources, computer learning, online instruction, video watching, and constant rotation on the learning process and active teacher engagement that give us proper attention in all its ramifications.*
Q5: *To what extent has your teacher encouraged you to teach the required teaching method in teaching scientific method? Explain*
M5: *Our teacher's excessive training and systemic approach have made it permanent for us to use the appropriate teaching strategies while we face our students at all levels of teaching.*

The findings from the excerpt of response to interview questions by Mele show that he could identify the theoretical constructs answered by the research question, which is believed to enhance critical thinking in the learning environment. These include Blended learning, collaborative learning, station rotation model, teaching method, and teaching aids. Table 5.22 summarizes the findings representing the research question that the interview portion tries to answer.

Table 6
A Summary of Mele's Response to Interview Questions

Theme	Response
Blended learning	The method adopted in teaching us is unprecedented in that a blended structure of learning was fully involved in teaching the in our scientific method class.
Collaborative Learning	we were also divided into cooperative groups to corporate with our peers in learning
Station Rotation Model	we were bombarded with grouping with our colleagues, many learning resources, computer learning, online instruction, video watching, and constant rotation on the learning process
Teaching Methods	there are several components of the teaching method in the instruction we received. Our instruction is so vast that we were given a constructive approach to learning with active teaching supervision.
Teaching Aids	we were introduced to so many accurate methods and apparatus for teaching science by our lecturer.

After receiving the intervention through the station, the interview findings show the rotation blended learning model in BSCLE. The results show that Mele was able to state the components of critical thinking. The analysis of the interview data shows that the participants have improved in terms of their necessary thinking skills. So, based on the participants' responses in the interview session have portrayed pedagogical strategies that were proven to enhance critical thinking. The learning environment on SRM-BSCLE constitutes pedagogical components proven to improve learners' critical thinking. Therefore, the learning environment has a significant impact on enhancing pre-service teachers' critical thinking skills. This can be deduced from the mention that Mele made regarding the pedagogical approach that improves learners' critical thinking.

Modu's Response to Interview Questions

Modu participated in the station rotation model in a group blended social, collaborative learning environment. He served as a timekeeper in his collaborative group. He earned low in his pre-test and post-test scores. Although Modu has scored low in the SRM-BSCLE, it does not mean that he is a poor candidate; his score is commensurate with those of the highest ranking in the conventional approach groups. Therefore, this indicates that the intervention was successful. In this section, Modu's response to interview questions will be presented in detail, and later the summary of the results will be presented in Table 7.

Q1: *Are there components of teaching methods? If so, what are they?*
M1: Yes, of course. There are components of the teaching method in the instruction we received in our Scientific method class. To be precise, we are taught several methodologies of teaching. Such may include the following: Blended learning through rotation and shift in the learning process, Collaboration learning in which our teacher divides us into groups, Task-

based education where several tasks were given to us by our lecturer, Active participation on our part as students, Active teacher engagement in all its ramification.
Q2: *If you were asked to analyze the scientific teaching method, how would you do so?*
M2: *If I am asked to give an account of my analysis of the scientific teaching method, I will confidently tell you that the strategy is all about confidence building between the teacher and the learners, which might lead to a permanent change of behavior among the learners. For example, those methods learned are vital in changing the attitude and expectations of learners in the cause of attending such a course. Therefore, it is believed that the Scientific method has numerous approaches and techniques for learning.*
Q3: *Can you think of a situation in a classroom setting where you felt that your ability to teach scientific methods was enhanced after attending this course?*
M3: *This is absolute, and I can relate to you that my ability to teach science is significantly and explicitly enhanced to a level that I can teach with complete confidence based on the instruction we received, which is based on explicit student-centered learning that comprises of active learning engagement.*
Q4: *Does the learning environment provide the avenue for the ideal condition to teach pre-service teachers to learn methods of teaching science?*
M4: *As I observed, the classroom setting is a kind of environment full of instructional activities that qualify it to be a learner-centered environment that is habitable to the classroom constitutes to teach a scientific method. The classroom condition is delightful and conducive to any form of learning.*
Q5: *Can you freely comment on whether there is a need for improvement or otherwise regarding teaching pre-service teachers to learn methods of teaching science?*
M5: *The need to uphold the rigorous instruction that comprises group learning coupled with computer instruction is paramount. I will also want to comment on sticking to the constructive form of education while teaching pre-service teachers because it taught me a lot.*
Q6: *To what extent has your teacher encouraged you to teach the required teaching method in teaching scientific method? Explain*
M6: *Almost from the inception of attending this class, our teacher is constantly encouraging us to use appropriate methods and instructional aids while teaching sciences.*
Q7: *Do you acknowledge that there is a good practice of teaching the scientific method after enrolling in this class?*
M7: *The instruction has given me experiences in knowing fully the most pressing method, teaching aids, and apparatus to be deployed while teaching the science methods to my students.*

In his response, he could be able to identify all the theatrical constructs believed to enhance critical thinking in the learning environment. These include Blended learning (BL), Collaborative Learning (CL), Station Rotation Model (SRM), Teaching Method (TM), and Teaching Aid (TA). The participant clearly states these elements. Below are the excerpts from the interview with the participant. Table 7 summarizes the findings representing the research question that the interview portion tries to answer.

Table 7
A Summary of Modu's Response to Interview Questions.

Theme	Response
Blended learning	Blended learning through rotation and shifts in the learning process
Collaborative Learning	Collaboration learning is when our teacher divides us into groups.
Station Rotation Model	Blended learning through rotation and shifts in the learning process
Teaching Methods	I can teach with absolute confidence based on the instruction we receive, based on explicit student-centered learning that comprises active learning engagement.
Teaching Aids	The instruction has given me experiences in knowing fully the most pressing method, teaching aids, and apparatus to be deployed while teaching the scientific method to my students.

The interview findings show that after receiving the intervention through the station rotation blended learning model in BSCLE, Modu has been able to state these identified in this study. The findings show that Modu was able to state the components of the learning environment. The analysis of the interview data showed that the participant could mention that the pedagogical approaches used in the learning environment improved his learning outcome. Furthermore, based on the proven facts from previous studies, these pedagogical strategies enhance critical thinking. Though there is no direct instruction on critical thinking as a course among the pre-service teachers in the experimental group on SRM-BSCLE, the techniques and strategies adopted for the research were proven to enhance learners' critical thinking. The learning environment has a significant impact on enhancing pre-service teachers' critical thinking skills. This is because the participant has identified themes that were earlier projected to improve their critical thinking.

Shehuram's Response to Interview Questions

Shehuram participated in the station rotation model in a group blended social, collaborative learning environment. She served as a speaker in her collaborative group. She got the highest score in her pre-test and post-test scores. In this section, Shehuram's response to interview questions will be presented in detail, and later, the summary of the results will be presented in Table 8.

Q1: *Are there components of teaching methods? If so, what are they?*

S1: *Well! I can boldly and categorically confess to you that the instruction we received has been enriched with many different components of teaching. This is because our instructor had used a combination of several methods. For example, the teacher grouped us into groups of six, and each of the groups played a specific role at a time; we were also assigned to rotate on a computer and work collaboratively. We learned based on collaboration with rigorous face-to-face teacher guidance with computer and screen-recorded instruction.*

Q2: *If you were asked to analyze the scientific teaching method, how would you do so?*

S2: *There are several methods of teaching science; let me mention the ones that are very important in attracting students' attention: demonstration method, project method, mastery learning, laboratory approach, concept mapping, task-based learning, collaborative learning, corporative learning, discovery method, experimental learning, inductive and deductive method.*

Q3: *Can you think of a situation in a classroom setting where you felt that your ability to teach scientific methods was enhanced after attending this course?*

S3: *Before now, I had the notion of teaching my students with few teaching methods; however, now I knew several methods of teaching coupled with proper use and application of instructional aids that could match any situation I found myself in a classroom.*

Q4: *Can you think of a situation in a classroom setting where you felt that your ability to teach effectively was not enhanced after attending this course?*

S4: *Absolutely NO! Because the instruction we received over the past few weeks has improved my talent as a science teacher. As I mentioned earlier, I am educated on the proper use and application of various teaching and instructional aids methods.*

Q5: *Does the learning environment provide the avenue for the ideal condition to teach pre-service teachers to learn methods of teaching science?*

S5: *The classroom environment is full of activities ranging from working in collaborative groups, working with computers, and active teacher engagement in the classroom. A kind of blended instruction which provides us with a high spirit of classroom engagement. Indeed, we are placed in an ideal setup that gives us a good platform for learning the arts of science.*

The scientific method could be learned in an environment where students were grouped with different tasks, coupled with the teacher's active participation and his students. Our instructor fully engaged us in an organized form of learning in which attention was given to us on an individual and group basis.

Q6: *Can you freely comment on whether there is a need for improvement or otherwise regarding teaching pre-service teachers to learn methods of teaching science?*

S6: *I will strongly recommend that to improve science teaching, I prefer that engaging us in fieldwork or practical work like excursion and visit to the accurate site to see a practical demonstration of what has been taught in the class may help in knowing science teaching very well.*

Q7: *To what extent has your teacher encouraged you to teach the required teaching method in teaching scientific method? Explain*

S7: *Following the instruction we received in EDU301D class, our instructor has encouraged us to use the appropriate task, material, and method while teaching our science students. For example, we are encouraged to use a laboratory approach to conduct specific experiments that require chemicals and a mixture of tissue.*

Q8: *Do you acknowledge that there is a good practice of teaching the scientific method after enrolling in this class?*

S8: *The blended nature of the class gave me some confidence that placed me to assume to be a professionally trained science teacher that effectively teaches his students to learn the concept at hand.*

Based on the result of the interview data, the excerpt from Shehuram's response was able to identify theoretical constructs covered by the research question. This indicates that the participant showed a high awareness of the learning environment, built on pedagogical approaches that were believed to enhance learners' critical thinking skills. Therefore, based

on the interview findings, the participant has demonstrated that the learning environment could help strengthen her critical thinking. Below are responses to the interview question based on the emerged themes. Table 8 summarizes the findings representing the research question that the interview portion tries to answer.

Table 8
A Summary of Shehuram's Response to Interview Questions.

Theme	Response
Blended learning	The blended nature of the class gave me some confidence that placed me to assume to be a professionally trained science teacher that effectively teaches his students to learn the concept at hand.
Collaborative Learning	The classroom environment is full of activities that range from working in collaborative groups.
Station Rotation Model	We were also assigned to rotate on a computer and work collaboratively. We learned based on collaboration with rigorous face-to-face teacher guidance with computer and screen-recorded instruction.
Teaching Methods	I can boldly and categorically confess to you that the instruction we received has been enriched with many different components of teaching. This is because our instructor had used a combination of several methods.
Teaching Aids	I knew several methods of teaching coupled with proper use and application of instructional aids that could match any situation I found myself in a classroom.

Based on the above table, the results of the interview with Shehuram indicate that she was able to state the components of critical thinking. This is because the participants in the interview session have portrayed pedagogical strategies that were proven to enhance critical thinking. Therefore, the learning environment has a significant impact on improving pre-service teachers' critical thinking skills. This is because the participant, in her response to the interview question, has identified the theoretical elements the research question in this study seeks to address.

Ali's Response to Interview Questions

Ali participated in the station rotation model in a group blended social, collaborative learning environment. He plays the role of a group moderator in his collaborative group. He got a medium score in his pre-test and post-test scores.

The present section asks about the participant's views on the learning environment. The purpose was designed to explain and support the findings of the experimental study with intervention. Thus, the intervention findings on SRM-BSCLE indicate that pre-service teacher critical thinking was enhanced in measuring the scores in general critical thinking and teaching method-related critical thinking tests. In this section, Ali's response to interview questions

will be presented in detail, and later the summary of the results will be presented in Table 9. The extract from the question and answer session is shown below:

Q1: *Do you think understanding the teaching science method improves after attending this course? If so, how? And if it is not, why?*
A1: *The knowledge I obtained on this course so far from day one to date is unmatched for the simple fact that the training capitulates me and the element of the development in terms of the scientific approach that I will teach to my students in a well-organized scientific training adopting several methods which are in line with the teaching and learning of science.*
Q2: *Are there components of teaching methods? If so, what are they?*
A2: *Yeah, I confidently and specifically tell anyone that the training imparted to us has undoubtedly enhanced teaching and learning methods. Since the trainer employed not only a single approach or technique in instructing the course, for instance, the teacher allotted a group to everyone with a total No. of 6 in a group, and all the group played their role differently time the teacher asked us to use the computer collaboratively between one group.*
A3: *We learn interdependently under a collaborative method through our lecture's guidance with computer and video recorded instructions.*
Q4: *If you were asked to analyze the scientific teaching method, how would you do so?*
A4: *The critical part of a teacher for me to play is choosing a suitable teaching method and being widely knowledgeable in every aspect of methods I adopt in teaching science. The few methods are as follows: project base method, demonstration method, collaboration method, grouping, etc.*
Q5: *Can you explain was it looks like? Please shade more light as much as you can. How does the situation enhance your ability to teach effectively?*
A5: *Now I possess several types of teaching strategies, all together with manipulation of instructional and teaching aids, which stand the test of time and situational changes in a classroom situation mostly, I made to understand that working together with the trainee is very improving and exciting.*
Q6: *Does the learning environment provide the avenue for the ideal condition to teach pre-service teachers to learn methods of teaching science?*
A6: *The scientific classroom setting has numerous activities, including online learning, video instruction, collaborative group, activities through a computer, teaching activities in the classroom, blended teaching, and understanding that provide all the trainees with a high level of activities or engagement. However, all class members were positioned in a perfect and complete mode setup that provided all the trainees with an effective platform to secure a scientific method.*
A6: *As an individual trainee, I believe the scientific method can be learned in a place such as a classroom and should be grouped and assigned with varieties of assignments joined together with active participation on the part of the students always, we were urged by the teacher in an organized form of training, and absolute attention was provided to all members either individually or as in the group basis*
Q7: *Can you freely comment on whether there is a need for improvement or otherwise regarding teaching pre-service teachers to learn methods of teaching science?*
A7: *I joined this course with great support that regards teaching pre-service teacher scientific methods to improve the scientific method and specifically to engage all the trainees in the aspect of practical work, which includes excursion and visitation of the industrial side for*

physical and practical demonstration of what has been trained while daring the training period.

Q8: *To what extent has your teacher encouraged you to teach the required teaching method in teaching scientific method? Explain*

A8: *The training we gained in our scientific method teaching class to adopt the most efficient and appropriate approach to the scientific method. For example, we are urged to list a few science methods and proper teaching aids the teacher applies the activities under the scientific method.*

Q9: *Do you acknowledge that there is a good practice of teaching the scientific method after enrolling in this class?*

A9: *Yes, putting up all the class attendance, I have broadened my horizon of knowing the basics of teaching science. The simple fact that the blended nature of learning has provided some sense of confidence that places all the trainees to assume and be professionally trained that can effectively teach trained the trainees to acquire the scientific method of approach.*

Based on the extract of response to interview questions by Ali on identified themes in the SRM-BSLCE group. In his answer to the interview question, the participant has been able to locate theoretical variables that research question (4) that this study seeks to address. These variables are proven to enhance critical thinking. These variables include includes Blended learning (BL), Collaborative Learning (CL), Station Rotation Model (SRM), and Teaching Method (TM). Table 9 summarizes findings from the response to interview questions by Ali.

Table 9
A Summary of Ali's Response to Interview Questions

Theme	Response
Blended learning	Blended teaching and learning that provide all the trainees with an elevated level of activities or engagement
Collaborative Learning	The teacher allotted a group to everyone, with a total of 6 in a group. All the group played their role differently; the teacher asked us to use the computer collaboratively between one group.
Station Rotation Model	The scientific classroom setting has numerous activities, including online learning, video instruction, collaborative group, activities through the computer, and teaching activities in the classroom.
Teaching Methods	It is imperative to mention some of my methods to get the class members' attention. The few methods are as follows. Project base method, demonstration method, collaboration method, grouping
Teaching Aids	I possess several teaching strategies, all together with manipulation of instructional and teaching aids that stand the test of time and situational changes in a classroom situation.

The interview results show that after receiving the intervention through the station rotation blended learning model in BSCLE, the participant could state these identified in this

study. The findings show that Ali could express the components of the learning environment. The analysis of the interview data shows that the participant has improved in terms of their critical thinking skills. The participants in the interview session have portrayed pedagogical strategies that were proven to enhance critical thinking. Though there is no direct instruction on critical thinking in the intervention group, there is an array of pedagogical approaches proven to improve critical thinking among the pre-service teachers in the intervention on SRM-BSCLE. The learning environment has a significant impact on enhancing pre-service teachers' critical thinking skills. This has correlated with the quantitative data and shows a considerable difference between the experimental and control groups. The result of the quantitative data shows that the experimental group scored a high mean score compared to the control group.

Talala's Response to Interview Questions

Talala participated in the station rotation model in a group blended social, collaborative learning environment. She served as an envoy in her collaborative group. She got a low score in her pre-test and post-test scores. In this section, Talala's response to interview questions will be presented in detail, and later the summary of the results will be presented in Table 10. The extract from the question-and-answer session is shown below:

Q1: *Do you think understanding the teaching science method improves after attending this course? If so, how? And if it is not, why?*

T1: *The instruction, based on multiple techniques, is unique and helps us understand the application and utilization of scientific methods in so many situations.*

Q2: *Are there components of teaching methods? If so, what are they?*

T2: True talk! There are many elements of teaching methods: collaborative learning (groping), blended learning with both face-to-face instruction, online learning coupled with video learning, learner-centered approach to education, and directed learning in which teacher guides us in areas of special needs. The above, I believe, were all elements or components of teaching which has helped us to nearly understand the concept presented to us while attending such a course.

Q3: *Does the learning environment provide the avenue for the ideal condition to teach pre-service teachers to learn methods of teaching science?*

T3: *As I mentioned earlier, the environment within which we received instruction on the scientific method comprises a learner-centered approach that gives room to all conditions for learning. To be precise, I will categorically tell you that the teachers have created a conducive environment for us to learn the art of teaching science methods to our students.*

T3: *In learning, we are placed on learning through various means: for example, we are engaged in Video and online learning, browsing through the internet to gather resources, and sometimes watch videos on teaching methods and effective use of science laboratories. Also other forms of learning include Collaborative instruction, face-to-face instruction, and computer-supported instruction.*

Q4: *To what extent has your teacher encouraged you to teach the required teaching method in teaching scientific method? Explain*

T4: *We are repeatedly asked to use the appropriate teaching method while teaching our science students. Moreover, teachers' ethical role and teaching aid application were said to be very fundamental in the teaching profession.*

Based on the extract of response to interview questions by Talala. In her response, the participant could be able to identify variables that research question 8 seeks to address. The variables in the SRM-BSCLE, according to the results of quantitative data, the learning environment enhances critical thinking. Below is the excerpt for the response to the interview question based on the identified themes for this study section. Table 10 summarizes the findings from the response to interview questions by Talala.

Table 10
A Summary of Talala's Response to Interview Questions

Theme	Response
Blended learning	Blended learning with both face-to-face instruction, online learning coupled with video learning
Collaborative Learning	There are many elements of teaching methods: collaborative learning (groping).
Station Rotation Model	Video and online learning, browsing through the internet to gather resources, and sometimes watching videos on teaching methods and effective use of science laboratories.
Teaching Methods	We are repeatedly asked to use the appropriate teaching method while teaching our science students.
Teaching Aids	Teachers' ethics role and teaching aid application were said to be very fundamental in the teaching profession

The interview findings show that Talala, after receiving the intervention through the station rotation blended learning model in BSCLE, has been able to state these identified in this study. The findings show that Talala was able to state the components of critical thinking. The interview data analysis indicates that Talala has improved her critical thinking skills. This is because the participants in the interview session have portrayed pedagogical strategies that were proven to enhance critical thinking. Nevertheless, there is no direct instruction on critical thinking among the pre-service teachers in the intervention on SRM-BSCLE. Still, the techniques and strategies adopted for the research enhanced critical thinking among learners. The learning environment significantly impacts pre-service teachers' critical thinking skills.

Discussions

Pre-service Teacher's Views on Station Rotation Model with Blended Social Learning Environment

The study aimed to determine pre-service teachers' views on enhancing critical thinking through a station rotation model with a blended social learning environment. Based on the feedback obtained after the intervention session with pre-service teachers in the SRM-BSCLE group, their views supported the findings of the quantitative aspect of the study, that the learning environment enhances pre-service teachers' critical thinking skills. Therefore, the results suggested that pre-service teachers' critical thinking was enhanced after implementing SRM-BSCLE; this learning environment has been theoretically and empirically proven to improve critical thinking. Similarly, the study's findings also revealed that pre-

service teachers had demonstrated elements of blended learning, collaborative learning, station rotation model, teaching method, and learning materials. These themes are considered a strong indicator for enhancing pre-service teachers' critical thinking. Below is a detailed explanation of the pre-service teachers' findings on the learning environment.

Blended Learning

According to Cakir (2013); Kucuk & Sahin (2013); Lee et al (2012), blended learning enhances critical thinking among learners as a result of the synthesizing learning approach that combines active teacher guidance and computer instructions. These assertions were further ascertained by (Lee et al., 2012), which found that learners' critical thinking was enhanced in a blended learning environment. Pre-service teachers in the present study were adequately guided by their teachers through different learning tasks that gave them a proper understanding of the concept. This finding agrees with previous research on blended learning. Thus, blended learning has been considered a powerful tool to improve learners' experience of the concept (Byndas, 2017).

As rightly observed from the extract of the above statements, the learning environment that incorporates blended learning enhances pre-service teachers' critical thinking. Omiola (2012); Tomlinson & Whittaker (2013) assert that the rigorous activities in a blended learning environment enhance learners' critical thinking. These findings concur with Noraini (2016); Sum (2012) that blended learning in a teacher education encourages pre-service teachers' collaboration and interaction and enhances their critical thinking skills. Based on this, it is evident that the learning environment positively affects pre-service teachers' critical thinking.

Based on the present study's findings, it has been observed from the excerpt of the interview with participants from the experimental group that blended learning has been the significant component that promotes their learning. Perhaps, the concept is comprised of all the essential elements that put together the learning environment. The researcher participants have broadened their understanding of teaching science methods through the enriched learning environment that involves face-to-face teacher guidance and the massive influence of online learning that allows them to learn. In response to the interview questions, the pre-service teachers have pointed out that they have been engaged in several learning activities that improved their learning. Through the interview, the participants had accorded emphasis that they were exposed to several learning activities through different learning modalities.

Collaborative Learning

A collaborative learning environment does not only encourage an active exchange of ideas among pre-service teachers, but it encourages learners' critical thinking (Gokhale, 1995; Johnson & Johnson, 1994; Nechita et al., 2014). In the present study, pre-service teachers are engaged in several activities to enhance their critical thinking skills. This assertion can be proved by the nature of the learning environment that incorporates small group learning, social interaction, a station rotational blended learning model that engages learners in different learning modalities, and pedagogical approaches that encourage active interaction, participation, and critical thinking. This finding concurs with (Sadeghi, 2012). The author found that a collaborative classroom is saddled with numerous activities that prompt learners to have a notion of creating an atmosphere filled with critical thinking values. Therefore, it is

apparent that collaborative learning that was enveloped with collections of this magnitude of activities may enhance pre-service teachers' critical thinking skills.

According to the research participants, the presents of collaborative activities have improved their understanding of properly learned methods of teaching science. This result coincides with the findings of previous research. The use of multiple resources, activities, and groupings of learners in small groups in teaching and learning could help pre-service teachers to clearly understand the concept being taught as well as improve their cognitive, reflective thinking capacity, which in turn, it enhances their critical thinking skills (Surif et al., 2012). A well-designed collaborative learning environment can effectively enhance pre-service teachers learning outcomes. Thus, pre-service in the interview session has shown a high degree of positive response to the pedagogical approach. For example, a learning environment comprised of collaborative learning, social interaction, small group learning, and numerous learning modalities emanated from the station rotation blended learning model. Therefore, there is a shred of convincing evidence that the collaborative learning environment can enhance pre-service teachers' critical thinking.

According to the research participants, the learning environment has exposed them to various learning activities needed in a modern classroom to promote learning. They mentioned how small group learning and collaborative activity had improved their skills and understanding of how they go about their future classroom activities.

Station Rotation Model

Pre-service teachers indicated a positive remark on how learning concepts through the station rotation model have broadened their understanding of methods of teaching science. In response to the interview questions, the pre-service teachers have pointed out that they have been engaged in various learning activities that improved their learning. During the interview, pre-service teachers reiterated that they were exposed to several learning activities through different learning modalities. These approaches include video instruction, learning through computers, interacting through collaborative groups, surfing the internet to get materials, and active teacher guidance. This finding coincides with a study by (Truitt, 2016) that found learners in a rotational model in a blended learning environment engage in several activities that include technology and pedagogical processes. Another finding that agrees with the presents study indicated that implementation of the station rotation model shows a high assessment that leads to the enhancement of learners' higher-order thinking (Powell et al., 2015).

The findings base on the response of the research participants indicates that a classroom full of technological gadget and learning approach to support learning is worth commendable. Therefore, every modern classroom should include technology and an active learning environment to encourage learning outcomes among learners. This learning model is very effective in several studies across the globe. For example, a study by (Byndas, 2017) found that implementing a blended learning model improves learners' reflective thinking and metacognition and develops their critical thinking skills. Therefore, implementing the blended learning model has a significant impact on pre-service teachers. The findings of their study revealed that the learning environment had shown a positive outcome among pre-service teachers. The pre-service teachers have linked technical support and a pedagogical approach to developing their teaching practice. These findings concurred with the current study. The participants in an interview have indicated that they will develop their teaching practice, especially after attending this course excerpt from the interview show that all the six pre-

service teachers in the interview have stated similar response in this regard. Applying different teaching strategies using technology in the classroom in teacher education is critical in presenting a good practice that may enhance pre-service teachers' critical thinking.

Teaching Method

It is a fact in the public domain that the social constructivist approach to learning enhances pre-service teacher critical thinking (Dantes, 2015; Demiral, 2018; Khalid & Azeem, 2012); this learning approach is widely accepted to promote active learners' participation in constructing their knowledge with the operational guidance of an adult. Thus, teaching methods have been placed within two distinct learning categories: a student-centered approach to learning of the constructivist family. The other is a teacher-centered approach to learning. The former is considered to develop learner cognitive abilities (Vygotsky, 1978); in order words, it promotes critical thinking among learners. The present study was built on the constructivist theory supporting learners' active involvement in constructing knowledge. Preservice teachers granted an interview in this regard; they have repeatedly emphasized the teaching method in the discussions. Though the pre-service teachers were familiar with some of the teaching methods before the intervention in their introductory methodology classes attended in their year one and year two, they affirmed to the researcher that they were not advanced to know its practical application until they participated in the present study. According to them, they have now become very conversant with the application of the method.

Based on their response, three of the six pre-service teachers responded with specific terms of mentioning teaching methods aligned with the constructivist approach. At the same time, the remaining three were general in their description of teaching methods. Happen said that 50% is enough to justify that pre-service teacher are assumed to specify the importance of a student-centered approach to learning. Based on the findings that pre-service teachers gain knowledge about the constructivist approach to learning, it revealed that pre-service teachers' critical thinking was enhanced. Other studies affirmed the results of the present study that research on student-centered teacher methods, a constructivist approach to learning enhances critical thinking among pre-service teachers (Basogain et al., 2018; Broadbent & Poon, 2015; Fang et al., 2017; K. Kim et al., 2013; Kong, 2014).

The application of a learning environment that has elements of constructivism like zone of proximal development (ZPD) and problem-solving may enhance learners' critical thinking (Basogain et al., 2018; Kim & Hannafin, 2011), as well it is widely reported in research that these pedagogical approaches enhance learners critical thinking skills. The study supported the above findings on the effect of active learning by (Kim et al., 2013). With group active collaborative, problem-based learning, the learning environment helped enhance pre-service teachers' critical thinking skills. Likewise, to improve pre-service teachers' critical thinking skills, instructional designers should employ active learning strategies in designing and implementing a learning environment (Kim et al., 2013). The authors further stated that the learning environment developed based on the integration of technology and constructivist learning theory may encourage critical thinking among learners (Fang et al., 2017).

Significant growth was achieved in pre-service teachers' critical thinking after engaging in an intervention with a learner-centered approach to learning (Kong, 2014). pre-service teachers in this learning environment are exposed to group learning, collaborative group, and obtained problem-solving techniques. In a meta-analysis conducted by (Broadbent

& Poon, 2015), student-centered learning strategies enhanced critical thinking. These include metacognition, collaborative engagement, self-regulative learning, and critical thinking skills. In a meta-analysis conducted by (Broadbent & Poon, 2015), student-centered learning strategies enhanced critical thinking. Therefore, it is evident that the application of SRM-BSCLE has further enhanced pre-service teachers' critical thinking ability.

Teaching Aids

Appropriate teaching apparatus in teaching and learning are considered essential elements that promote pre-service teacher learning outcomes (Forsyth, 2014; Furio et al., 2015; Singer et al., 2000). It is a fact that no teaching and learning process could be complete without apparatus to assist in instruction, especially in science teaching, the use of teaching aids is paramount. Therefore, no science teaching can be comprehensive without teaching aids. The instructor may require teaching materials to aid their education in a blended instruction. In the present study, instructional assistance combinations were employed to enhance learning among pre-service teachers in the experimental group. These learning materials are essential to the group's learning (Kirkwood & Price, 2014; Pearson et al., 2005; Singer et al., 2000).

The learning material used in this study includes computers, microphones, whiteboards, LED boards, Camtasia, and laptops. Based on the response of the participants, it has been observed that the use of a variety of teaching aids in the BSCLE has attracted the attention of the participants, and the multiple application of the learning materials has considered vital in supplementing the outcome of the research in the quantitative aspect of this study. Teaching aids belong to the family of constructivist approaches (Pearson et al., 2005), in which their application is meant to assist learners in understanding the concepts being taught. These learning tools are not only made for teachers' usage but are specifically employed to assist learners in acquiring learning and help facilitate teaching and learning. Furthermore, constructivist principles of learning vested its procedure on learners to have absolute control of the learning environment. Teachers' role in this learning approach is to facilitate and guide learners (Schneider & Krajcik, 2002; Van Driel et al., 2001). Based on that, learners need to work with teaching aid to construct their knowledge.

Therefore, this teaching allotted a significant role in enhancing pre-service teachers' critical thinking skills. Since no class of this nature could be successful without using or applying the needed instructional aids, these findings have explored another breakthrough. However, minimal attention was attributed to how teaching aid improves learners' critical thinking. Based on an extensive literature search, the researcher did come across limited studies that emphasize teaching aids in enhancing critical thinking among pre-service teachers (Pearson et al., 2005). the conclusion drawn from this finding is that teaching aids play a significant role in strengthening critical thinking among pre-service teachers. Therefore, methodology courses like teaching methods should take cognizance of incorporating the needed interactive tools and teaching aids to change the paradigm of teaching-learning (Forsyth, 2014).

Conclusion

The present study explores that implementing a station rotation blended learning social and collaborative learning environment has a positive effect on enhancing the critical thinking skills of science pre-service teachers. Moreover, it is shown that the social presence and zone of proximal teacher development in the learning environment positively influence

pre-service teachers' performance in the classroom. The conclusion is based on the pedagogical approach among the six participants in the transcript extracted from the responses selected to be relevant in the eleven interview questions that were designed to find out the participant's views about the learning environment purely designed on pedagogical approaches that were theoretical and empirically found to trigger critical thinking among learners. The questionnaire was designed to find out from the participants whether the learning environment has a significant impact on enhancing their critical thinking skills. The responses show that pre-service teachers have enhanced their critical thinking since they all have ascertained the existence of the theoretical components. Fortunately, all the participants have positively responded to the variables measured by the aim of the study. The participants have identified the pedagogical approach used in this study to enhance their critical thinking.

All the participants were able to identify the theoretical components of the research objectives in this research except Talala, who did not directly relate to the theoretical constructs in three dimensions. However, the three not clearly stated elements are related to them, and the attempts made may also be regarded as one of the variables. Happen was one lowest-scoring fellow in the experimental group; she has improved significantly by the intervention since her pre-test was realized to be compared to the highest in the control group. Therefore, the interview results suggest that the interview coincides with the quantitative aspect covered by this study. That pre-service teachers' critical thinking was enhanced.

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