



9E Learning And Teaching Model And Its Application In Higher Secondary Education School System

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Abstract: The purpose of this study was to implement the 9E Learning and Teaching Model (9E LTM). The impact of Critical Thinking Skills (CTS), analysis, and inference on students' statistics achievement observed through constructivist theory. A population of higher secondary school statistics students and 220 students sample was drawn, randomly. Two aggravation instruments were used: one for the 9E teaching and learning model, and the second was about learning statistics by analysing and inference CTS. The results showed a significant relationship between the CTS inference skill and the students' 9E learning and teaching model was 0.95. There was also a significant relationship between the inferences skill of CTS and 9E LTM in students. The results show that the 9E LTM is a more operative learning method to improve the analysis and inference of CTS. Consequently, it is acclaimed that statistics staff should adopt the 9E LTM for teaching, and better performance in analysing and inference CTS statistics.

Keywords: 9E Learning, Teaching Model, Analysis and Inference, Inferential Statistics, Critical Thinking Skills.

1. Introduction

Critical thinking skills play a crucial role in student learning around the world and are considered challenging for staff. Each time it has to do with teaching and learning, analyzing and inferring are complex for the student to understand the content with CTS. The 9E learning and teaching model has elicited engage, explore, explain, elaborate, evaluate, extend, echo, and e-search. These nine stages help the staff improve student learning and CTS. Learning statistics also helps with the emerging progression steps in analysis and inference. Positive change toward learning in the subject content area supports the learning process and strongly influences CTS. The main issue is that students are unable to analyze and infer statistical concepts through learning (Basri & Asari, 2019). In many circumstances, the lack of student learning in the 21st century is perceived in the content of statistics and in their learning methodology. Therefore, researchers Wahyuni, Sanjaya, Erman, and Jatmiko (2019) stated that past content learning concepts on inference and analysis were not conducive to better learning. Furthermore, a few studies have integrated CTS into the learning model (Carkit, 2013; Gurbuz, 2012; Sahin, 2014; Yerdelen, 2013).

The critical thinking concepts of the 9E Learning and Teaching Model must be incorporated into the learning process. Learning with the CTS needs to be examined in relation to the analysis and the inferences drawn from the established interpretations. This is often done using a testing instrument created to evaluate a student's learning according to the 9E LTM. The main objective of the study is to explore the analytical skill of CTS through the 9E LTM and to examine the inference skill of CTS through the 9E LTM in students, to measure the 9E LTM's effectiveness in teaching methodologies. The assessment tool was administered during the study. Analysis of the results of the analysis and inference skills.

In outdated teaching lines of attachment to the students, the related results, for example, Students' learning objectives, learning strategies, and concept of learning in education and what instruction strategy should be used to learn about analysing and inference (Din, 2020). Therefore, the focus of the reorganization of student learning in the field of statistics is to explore the 9E learning and teaching model for analyzing and inferring critical thinking skills among statistics students in the higher secondary education system in Pakistan. Students are further able to think CTS and imitate analysing and inferences. Most researchers find that the student only applies his own perception of learning to CTS when he adopts a new learning method (Ayish & Deveci, 2019). The teaching and learning model observes students' learning patterns, which are

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based on what they can learn naturally. Various learning models have been presented by researchers, which have improved students' learning skills, including 3E, 4E, 5E, 7E, and the recent 9E presented by Kaur and Gakhar (2014).

Therefore, this study assists students in using the 9E LTM to manage in modern workplaces. This study inspires faculty to use 9ELM, mainly when teaching inferential statistics, to improve student learning and opens the door for school officials to adapt 9ELM in the teaching of inferential statistics. Instructors should be encouraged to use 9ELM to upgrade the teaching methodology and make it more engaging, participatory, and satisfying. Researchers might use this study as relevant research to focus their attention on high school students' ability to analyze data and draw inferences using the determined 9E LTM when teaching inferential statistics.

2. Literature Review

Statistics are now mandatory in the curriculum across all studies, as they are recognized as an integral component of overall education. Knowing about statistics is distinct from knowing about an empirical subject such as mathematics, economics, or psychology. The learners can be taught how to "*find knowledge new to them*" and how to be convinced that what they have learned is factual, under the direction of a teacher. Statistics is the study of problem-solving. Statistics issues are comparable to all other problems that individual students approach. The aims or intentions of the learning process determine the teaching methodology. These priorities fall into three categories: Standards for knowledge and skills, comprehension, and real issues (Wei, Lin, Chen, & Chen, 2022).

In general, teachers want their students to learn statistics in a meaningful way, use it to address difficulties, and develop the statistical skills necessary to tackle the issues they face in daily life. Modern education, but not education, is necessary to acquire these skills and ensure that they last a period. Some educational methods have been used in the statistics education literature to teach and learn statistics. Although the 9Es teaching and learning paradigm is typically used to teach science because it is built on analysis and inference, some people have used it to teach statistics (Kramer, 2020).

The learning cycle was observed for 3E (Karplus & Their, 1967), 5E (Bybee, 1997), and 7E (Eisenkraft, 2003). Karplus & Their (1967) presented the "*5Es Learning Cycle*"; later, Roger Bybee (1997) modified it according to the Biomedical Sciences Syllabus Studies (BSCS) program, exploring how new knowledge or learning more about what is basic requires the development of an understanding of both our prior knowledge. Later on, the 9E teaching and learning model (Kaur & Gakhar, 2014). As well as the first information acquired through fresh investigations through 9E LTM. In the literature, various iterations of the learning cycle can be observed.

Constructivism is a teaching approach that examines how students conceptualize learning. This approach ensures that each student enters the learning environment with some prior knowledge, and, on the basis of this, they construct new knowledge. Based on Piaget's ideas of cognitive development and Vygotsky's theory of cognitive development, the constructivist learning method developed by Bruner is central (Suhendi, 2018). The constructivist method of learning assists students in giving meaning to their learning and thinking (Jarvis & Baloyi, 2020). Students who learn through exploration develop new knowledge by focusing on their circumstances (Zhong & Xia, 2020).

2.1 Critical Thinking Skills

Researchers describe critical thinking skills in a wide range of ways, depending on the context in which they were used. They all concur that Bloom has strong cognitive abilities. Critical analysis focused on choosing what to believe or how to act is described as critical thinking (Ardhian et al., 2020). Alsaleh (2020) stated that critical thinking is the application of cognitive techniques and approaches to improve the likelihood of a desired outcome. An expert opinion provided by Facione (1990) illustrates the utilisation of all competencies. It has subcategories for self-regulation, inference, analysis, evaluation, interpretation, and analysis. As a result, the research will use discussion as a method to help students by developing CTS, especially in analysing and inference. The researcher considers only analysis and inference to be critical thinking skills.

Different researchers emphasise the importance of helping statistics students at all educational levels enhance their critical thinking skills (Erdogan, 2019; Mahanal, Zubaidah, Sumiati, Sari, & Ismirawati, 2019). Mahanal et al. (2019) clearly indicate how applying critical thinking skills to statistics could improve learning inference and analysis. Additionally, it is acknowledged that developing critical thinking skills to their full advantage is essential for the learning experience (Sokhanvar, Salehi, & Sokhanvar, 2021). Hand, Chen, and Suh (2021) pointed out that the evidence and research show the advantages of encouraging critical thinking skills in students at all educational levels when studying statistics. It is acknowledged that developing one's critical thinking skills is a crucial component of academic learning (Brookfield, 2022). This clearly states that learning should be focused on improving critical thinking skills. All individuals are aware of the importance of critical thinking skills (Assi, Saad & Sankaran, 2022), and they have been proposed for use across all subject areas (Paul & Elder, 2019).

2.2 E-Learning Model

The E instructional model is a framework for analyzing how knowledge develops during learning exercises (Eisenkraft, 2003). In addition, various models, like 3E, were Explore, Explain, and Elaborate; other recommended approaches are 4E, Engage, Explore, Explain, and Evaluate. (Çalık & Ayas, 2005; Çalık, Ayas & Coll, 2010). The 5E instructional model was developed by Bayee (1997). Bayee (2015) presented a review of instructional theories that can teach methods efficiently. He maps the 5Es model to the five phases stated here: Engaging, Explaining, Elaborating, Exploring, and Evaluating.

The 5E approach to learning helps students with difficulties; it encourages students to participate in learning activities, supports their integration of new information with prior knowledge, and changes how they feel about learning statistics. The 5E learning process can also help students evaluate their different perspectives rather than limiting learning to what is found in the book (Cheng, Yang, Chang, & Kuo, 2015). However, prior to conceptual teaching and learning, it is essential to assess pupils' other beliefs and prior knowledge.

The 7E model is related to research by Eisenkraft (2003), who extended the BSCS 5E model; it is among the most popular and widely used teaching models applied today. Eisenkraft (2003) further identified seven prominent components: elicit, engage, explore, explain, elaborate, evaluate, and extend the model. Yerdelen (2013) conducted his study to investigate how the 7E learning model, with its terms improved, affects the competence of high school students in the teaching and learning process.

2.3 9E Learning and Teaching Model

To carry out the process of teaching and learning effectively, the process should incorporate active participation by both the student and the teacher. To do this, Kaur and Gakhar (2014) suggest using the 9E learning and teaching model. The nine different Es that must collaborate in teaching and learning to achieve greater proficiency make up the 9E teaching and learning process and are beneficial for analyzing and improving overall performance objectives. It considers the following:

- The knowledge and abilities provided to the students.
- When students are prepared to learn and achieve academic learning objectives and continually learn with a set of assignments, the subject matter is taught in the process.

2.3.1 Elicit

Acquiring the student's previous knowledge is essential, though. What prior knowledge do they have on the particular topic? It can all be conducted through discussion, short tests, and learning objectives. In addition, it is an excellent time to answer some questions and to determine the topics that interest students.

2.3.2 Engage

It comprises piquing learners' curiosity about a concept, informing them of what they already know, and making them aware of their own understanding of the concept. This phase serves as an introduction to get students excited about learning. Students are, therefore, not encouraged to provide the correct reasons.

2.3.3 Explore

In this phase, the students are particularly engaged. Through careful observation, students put their knowledge to use and acquire an understanding of the ideas. Interacting with students, they try to investigate scientific information. At present, teachers encourage students to use videos, the Internet, computers, and other resources to address these issues.

2.3.4 Explain

The teacher may be the most proactive in this phase. Students discuss their personal experiences with one another. Students are encouraged to contrast their prior knowledge with the new information and clarify how the old and new ideas are related. Different teaching strategies, including simulations, analogies, conversations, and movies, may be useful for teachers and learners.

2.3.5 Elaborate

Students are urged to incorporate and connect their new knowledge with their daily activities. To help students develop their critical thinking abilities, worksheets, sketching activities, and challenging situations might be used. To help students develop their critical thinking abilities, worksheets, sketching activities, and challenging situations might be used.

2.3.6 Evaluate

Students examine and make inferences about new knowledge of the concept(s) learned during the previous stages. Finally, teachers assess students' progress at this stage.

2.3.7 Extend

How can you convince learners to use or extend the knowledge in a different situation during this phase? Students draw connections within and outside the concept(s) or ideas being studied. They share the ability to interpret, integrate, and extend principles.

2.3.8 Echo

In this stage, known as the practice or repetition stage, learners are strengthening the key learning objectives that arose in the exploring and explaining stage. The teacher's job is to verify that the pupil has learned the concepts being taught and, afterward, to provide the essential recommendations or encouragement, as preferred. The information obtained even during the echo step is subsequently used further throughout the elaboration phase. Depending on the needs and interests, several levels of technology engagement may be used.

2.3.9 E-Search:

By embracing the use of technology in the process of delivering education, the "9th E" serves as the connecting element that unites those other "9 Es" in the model. Depending on the needs and interests, several levels of technology engagement may be used, as well as the students' and the teacher's preferences. We can reasonably assume that the 9E learning and teaching model represents one of constructivism's better-received revisions, given several studies (Morris, 2019). Awidi, Paynter, and Vujosevic (2019) also intended to assess the extent to which the fundamental strategy is integrated into learning about incorporating statistics to enhance learning based on students' concepts.

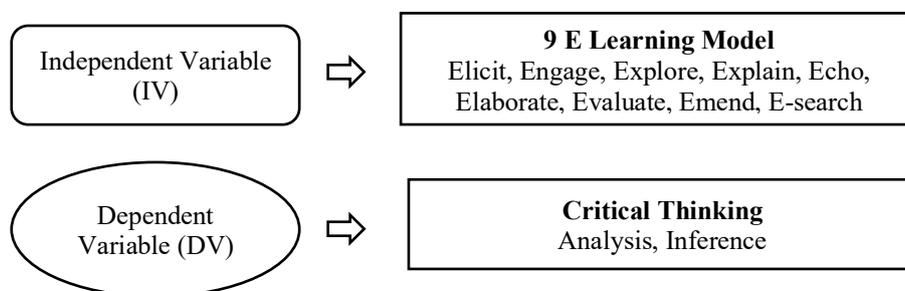


Figure 1: The variable of the study

2.4 Learning Analysing and Inference

The ability to think critically helps students improve their critical thinking skills. Analytical skills are crucial for students' learning because they enhance their ability to express concepts (Dewi & Primayana, 2019). Students can compare, generalize, and assign key ideas by analysis. Additionally, students can connect causes and consequences and draw conclusions (Malmia et al., 2019). It is widely acknowledged that students studying statistics can learn from the association between the 9E learning and teaching model and their ability to analyse and inference (Assi, Saad & Sankaran, 2022).

Identifying these relationships can be beneficial for both professionals and learners, enabling them to use the most effective instructional methods based on learners' knowledge to help students improve their ability to analyze and draw inferences. Putri and Maimunah (2020) stated that the development of students' critical thinking skills through learning analysis and inference is fostered. Some studies have revealed that learning, analysis, and inference skills are closely related (Holmes et al., 2021). Given that the 9E learning and teaching model may be crucial for developing critical thinking abilities and that higher secondary school students need to analyze and make inferences, investigations into their relationships are essential. They lack the ability to analyze, conduct analyses, and gain knowledge from challenging statistical topics. In light of this, the overall objective of the current research is to examine the relationship between the 9E learning and teaching model and the analysis and inference of critical thinking skills among statistics students in the higher secondary education system in Pakistan. The only element addressed in this research was inferential statistics, through analysis and inference.

3. Research Objectives

The main purpose of this study is to find students learning about analyse and inference of CTS with the following research objectives:

- i. To explore the analytical skills of CTS through the 9E learning and teaching model in students.
- ii. Examine the inference ability of CTS through the 9E learning and teaching model in students.

3.1 Research Questions

The following are the research questions of this research study:

- i. What is the analyzing skill of CTS through the 9E learning and teaching model in students?

- ii. What is the inference skill of CTS through the 9E learning and teaching model in students?

The research hypotheses are as follows.

- i. **Ho:** *There is no significant analysis skill of CTS through the 9E learning and teaching model in students.*
- ii. **Ho:** *There are no significant inferences of CTS skills through the 9E learning and teaching model in students.*

3.2 Methodologies

The population for this research includes all statistics students from higher secondary schools in the Multan district of Punjab Province. All second-year students of the Multan District Public High Schools in Pakistan's Punjab Province were considered the target population for the research study. However, dealing with the target population involves too much time and effort. The population restrictions of the research study only included the students who could be reached. In the Multan district, 750 second-year students were included in the chosen population for the academic year 2021–2022. Four Higher Secondary Schools (two boys and two girls) were selected as the study sample. A total of 220 students were included in the study sample, with 55 selected systematically from each GHSS. 33% of the students in the sample had less than 50% results, 33% had less than 70%, and 34% had less than 90%; these were selected from each school. A detail of the sample is given in Table 1.

Table 1: Sample of the study in terms of the school

Results	Percentage of Selected Students	No. of students Selected School			
		No.1	No.2	No.3	No.4
Below 50%	33%	18	18	18	18
Below 70%,	33%	18	18	18	18
Below 90%	34%	19	19	19	19
Total	100%	55	55	55	55

Source: Generated by the current study

3.3 Data Analysis

Table 2: Regression test for the relationship between the learning model and critical thinking skills

Variables	R	R Squared	Adjusted R Squared
9 E Learning Model and Critical Thinking Skills	0.48	0.225	0.214

Source: Generated by the current study

Table 2 shows that the correlation between the 9E learning and teaching model and critical thinking skills is 0.48, R² is 0.225, and adjusted R² is 0.214, indicating that 0.214 of the variation in CTS is explained by these variables.

Table 3: Variance analysis test for regression

Source	df	Sum of Squares	Mean Square	f	Sig.
regression	9	3537.514	1241.5	17.45	0.0001
residual	211	13355.16	64.231		0.0001
total	220	16803.126			

Source: Generated by the current study

The findings of the variance analysis are discussed in relation to the significance of the regression model, which is indicated by $F(9, 211) = 17.45$, $P < 0.0001$. The regression coefficient is examined in Table 4. The findings indicate that the 9E learning and teaching model variable can predict analysis and inferences (CTS).

Table 4: Regression coefficients for 9E learning and teaching Model and Analysis, Inferences (CTS)

Model	Unstandardized Coefficients		Standardized Coefficients		t	Sig.
	B	Std. Error	Beta			
(Constant)	5.401	3.67				
analysis	0.382	0.080	0.453		5.254	0.001
inferences	0.28	0.068	0.256		-0.04	0.52

Source: Generated by the current study.

Table 5: Pearson correlation coefficient for 9 E learning and analysis, inferences

Variable	N	Pearson value	sig
9 E learning Model	220	0.14	0.014
9 E learning Model - analysis	220	0.12	0.128
9 E learning Model - inference	220	0.16	0.025

Source: Generated by the current study

Table 5 shows the relationship between the 9E learning and teaching model and analysis, inferences (CTS), and its components. Results indicate a significant connection between 9E learning, teaching model, analysis, and inferences (CTS). Pearson's value is 0.14, which is positive and significant at the 0.05 level. Consequently, argues that if one improves, the other will increase. The results also indicate a significant relationship between the 9E learning and teaching model and the analysis and inferences (CTS), with a Pearson's value of 0.15 and a significance level of 0.025. However, there is no significant relationship between the 9E learning and teaching model and CTS's analysis and inference components. Pearson's values are 0.016 and 0.12, respectively.

3.4 Correlation Analysis

Determine the two-dimensional analysis and inference associated with EC, EG, EP, EL, EP EV, and EM approaches of the 9E learning and teaching model. Thus, with the use of 9 E learning, teachers construct and enhance CTS by adopting constructivist theory, i.e., Elicit (EC), Engage (EG), Explore (EP), Explain (EL), Echo (EO), Elaborate (EB), Evaluate (EV), Emend (EM) and E-Search (ES) in subject statistics. Table 5 below contains the analysis findings.

Table 6: Correlation analysis

Variables	1	2	3	4	5	6	7	8	9	10	11
Analysis	1										
Inferences	.52**										
CTS	.48**	.62**									
Elicit (EC)	.41**	.35**	.49**								
Engage (EG)	.31**	.36**	.34**	.61**							
Explore (EP)	.38**	.41**	.43**	.33**	.45**						
Explain (EL)	.27**	.30**	.38**	.21**	.31**	.39*					
Elaborate (EB)	.36**	.39**	.45**	.44**	.43**	.38**	.46**				
Echo (EO)	.36**	.33**	.38**	.39**	.37**	.33*	.29**	.55**			
Evaluate (EV)	.30**	.38**	.36**	.27**	.30**	.36**	.38**	.31**	.39**		
Emend (EM)	.39**	.41**	.40**	.36**	.39**	.35**	.34**	.41**	.35**	.53**	
E-Search (ES)	.38**	.36**	.27**	.32**	.38**	.36**	.38**	.30**	.34**	.38**	.41**

*Correlation is significant at the 0.05 level (2-tailed), **Correlation is significant at the 0.01 level (2-tailed)

Source: Generated by the current study

- i. The 9E learning and teaching model includes elicitation, engagement, exploration, explanation, echo, elaboration, evaluation, emendation, and search by electronic means. With 36 items that measured 9 phases of learning. Cornbach's alpha coefficients were .71(elicitation), .80 (engagement), .75 (exploration), .82 (explanation), .79 (echo), .83 (elaboration), .81 (evaluation), .71(emendation), .77(e-search) and for the 9E learning and teaching model, the questionnaire was 77.
- ii. The critical thinking skills test was developed as a benchmarking tool for the skill evaluation of higher secondary school students. There are 60 multiple-choice questions in this test, and they evaluate two levels: the ability to address the questions through analysis and inference is limited. The Cronbach's alpha coefficients in this research were .72 for analysis, .70 for inference, and .81 for the entire test. Data were analysed using SPSS 23.0 statistical analysis program. Regression analysis and correlation were used to determine the relationship between independent and dependent variables.

The findings revealed a positive correlation between the CTS 9E learning, teaching, analysis, and inference components. The lowest correlation was observed between the analysis component and the explanation (EL) 9E learning and teaching model ($r=.21$, $p<.01$). In the inference component, the highest correlation was observed between the dimension of the inferences and the elaborate 9E learning and teaching model ($r=.45$, $p <.01$). A strong relation and a significant, meaningful difference were observed between both independent variables ($p <.01$). There was a medium-level correlation between two dependent variables of CTS ($r =.62$, $p<.05$) and EO ($r =.55$, $p<.05$), EM ($r =.53$, $p<.05$), EG ($r =.61$, $p<.05$). Significant correlations occurred between the CTS analysis and inferences components and 9E learning and teaching model.

3.5 Analysis Of Variance CTS By 9 E And Teaching Model

The relationship between the CTS two-dimensional analysis and inferences and the 9E learning and teaching model was examined using Analysis of Variance (ANOVA). The results are presented in Table 7 below.

Table 7: Analysis of Variance Results for 9E LTM of Analysis and Inferences (CTS)

CTS	9 E Learning & Teaching	N	M	SD	Mean Square	F _(3, 221)	P
Analysis	Elicit	220	8.03	1.68	4.532	3.631	.149
	Engage	220	6.68	1.13			
	Explore	220	7.64	1.68			

CTS	9 E Learning & Teaching	N	M	SD	Mean Square	F _(3, 221)	P
Inferences	Explain	220	8.20	1.60			
	Elaborate	220	7.19	1.41			
	Echo	220	7.83	1.52			
	Evaluation	220	7.22	1.39			
	Emend	220	6.55	1.28			
	E-search	220	6.27	1.10			
	Elicit	220	8.05	1.14		3.543	.009
	Engage	220	7.18	1.11			
	Explore	220	7.63	0.83			
	Explain	220	7.11	1.39			
	Elaborate	220	8.18	1.30			
	Echo	220	7.83	1.46			
	Evaluation	220	8.15	1.29			
	Emend	220	7.55	1.61			
	E-search	220	6.14	0.66			

*p<.01

Source: Generated by the current study

The results showed no significant differences in the analysis dimension ($f=3.631$, $p<.01$) in terms of learning and teaching of 9 E. In the analysis dimension, E-search had lower scores ($M= 6.27$, $SD= 1.10$) than emend ($M= 6.55$, $SD= 1.28$) and engage ($M = 6.68$, $SD = 1.13$) ($F = 3.631$, $p<.01$). On the dimension of inferences, E-search ($M = 6.14$, $SD=0.66$) had lower scores than explain ($M = 7.11$, $SD =1.39$) and engaged ($M =7.18$, $SD=1.11$) ($F = 3.543$, $p<.01$).

The analysis of the score on the CTS dimensions scale, explanation ($M = 8.20$, $SD =1.60$), and elicitation ($M =8.03$, $SD =1.68$) had higher scores than echo ($M=7.83$, $SD=1.52$) and elaborate ($M = 8.18$, $SD = 1.30$). Analysis of the inferences dimension and analysis scores of the CTS scale revealed a large effect size. The size of the other dimension's influence was determined to be moderate (Assi, Saad, & Sankaran, 2022). On the analysis and inference aspects, teaching with 9E LTM had a significant influence.

4. Conclusion And Discussion

In this study, the influence of the 9E teaching and learning model (9E TLM) on the ability of students studying statistics in Pakistan's higher secondary education system to analyze and make inferences was investigated. The findings of the regression and correlation analysis revealed that a unique 9E teaching and learning model had a substantial impact on CTS. We discuss the significant connections between the 9E TLM and analysis, and moreover, with inferences. Students who follow the 9E TLM frequently allow students to explore, analyze, and draw inferences. The findings of this research are similar to previous research, and research has shown important connections between 9E TLM and CTS (Assi, Saad & Sankaran, 2022; Ching & Chaun, 2004).

At the outset, the 9Es learning model is used to construct inferences and analyses that teachers help learners gain in a thoughtful way, one that will improve learners' CTS learning. Learners can learn with the 9E TLM. To ensure that teachers will continue to educate using 9E TLM while demonstrating their deepest gratitude, and in their content learning, students will ensure adherence to learning analysis and inference. This article provides recommendations for the analytical and inferential abilities that students might improve in their learning, and how to integrate students' learning of these skills with their 9E TLM. Students in higher secondary schools would learn the skills according to the studies, and they were capable of assessing and recognizing arguments through analysis, questioning evidence, making coincidence judgments, and drawing other conclusions through inferences.

The significance of the research on the connections between the 9E learning and teaching model and learning by way of analysis and inferences (CTS) goes further than just adding to the existing literature, but also in regard to its significant effects on students' learning, education, and development of academic progressions in analyzing an argument, identifying an argument, and examining ideas. The 9E learning and teaching model supports learning through inferences (CTS); the development of analysis and inference skills might result from education that fully considers the learning model, improving skills in querying evidence, conjecturing alternatives, and drawing conclusions.

According to this study, 9E LTM can strengthen educational impacts. The disparity between the students' learning phases includes suggestions for a more intricate 9E LTM to include in order to effectively maximize the educational benefits. Teachers should be encouraged to use the 9E LTM approach because it has a high impact on learning, and to eventually incorporate it into their own more effective teaching strategies. Furthermore, the government of Pakistan made a wise choice by opting to implement a constructivist approach to teaching across all levels and subjects in K–12 schools. This is evidenced by the strong effect of 9E LTM reported in 5 primary studies. Additionally, to make it easier for higher secondary school teachers to adopt the researchers' findings on

the usefulness of the 9E LTM, it would be helpful for university-level researchers to serve as counselors during a course. The fact that the students engaged in the assignment more promptly. The fact that short-term implementations of 9E LTM have been more successful when they are unexpected may be the reason for this. When participating in short- or long-term research investigations, researchers could use 9E LTM to compile all their knowledge. As a result, the CTS in the 9E TLM can be used to assess learning and examine analyses and inferences of student learning.

References

- Abdi, A. (2012). A study on the relationship of thinking styles of students and their critical thinking skills. *Procedia-Social and Behavioral Sciences*, 47, 1719-1723. <https://doi.org/10.1016/j.sbspro.2012.06.889>
- Alsaleh, N.J. (2020). Teaching Critical Thinking Skills: Literature Review. *Turkish Online Journal of Educational Technology-TOJET*, 19(1), 21-39.
- Ardhian, T., Ummah, I., Anafiah, S., & Rachmadtullah, R. (2020). Reading and Critical Thinking Techniques on Understanding Reading Skills for Early Grade Students in Elementary School. *International Journal of Instruction*, 13(2), 107-118. <https://doi.org/10.29333/iji.2020.1328a>
- Assi, K. J., Saad, N., & Sankaran, S. (2022). Improving Students' Evaluation and Explanation Skills in Statistics using 9 E Teaching and Learning Model: an Experimental Study. *Journal of Educational Sciences*, 6(2), 210-224.
- Assi, K. J., Saad, N., & Sankaran, S. (2022). The Effect of 9 E Instructional Learning and Teaching Model on Students' improvement Critical Thinking Skills. *Tianjin Daxue Xuebao (Ziran Kexue yu Gongcheng Jishu Ban)/ Journal of Tianjin University Science and Technology*, 55(4). <https://doi.org/10.17605/OSF.IO/AJN4S>
- Awidi, I. T., Paynter, M. & Vujosevic, T. (2019). Facebook group in the learning design of a higher education course: An analysis of factors influencing positive learning experience for students. *Computers & Education*, 129, 106-121. <https://doi.org/10.1016/j.compedu.2018.10.018>
- Ayish, N., & Deveci, T. (2019). Student Perceptions of Responsibility for Their Own Learning and for Supporting Peers' Learning in a Project-Based Learning Environment. *International Journal of Teaching and Learning in Higher Education*, 31(2), 224-237.
- Basri, H., & As' ari, A. R. (2019). Investigating Critical Thinking Skill of Junior High School in Solving Mathematical Problem. *International Journal of Instruction*, 12(3), 745-758. <https://doi.org/10.29333/iji.2019.12345a>
- Brookfield, S. D. (2022). Teaching for critical thinking. *Handbook of Research on Educational Leadership and Research Methodology*, 311-327. <https://doi.org/10.4018/978-1-6684-4144-2.ch017>, Viktor Wang (California State University, San Bernardino, USA) IGI Global
- Bybee, R.W. (1997). *Achieving Scientific Literacy*. Portsmouth, N.H.: Heinemann.
- Bybee, R. W. (2015). *The BSCS 5E instructional model: Creating teachable moments*. NSTA Press, National Science Teachers Association.
- Çalık, M., & Ayas, A. (2005). An analogy activity for incorporating students' conceptions of types of solutions. *Asia-Pacific Forum on Science Learning and Teaching*, 6(2), 1-13.
- Çalık, M., Ayas, A., & Coll, R.K. (2010). Investigating the effectiveness of usage of different methods embedded with four-step constructivist teaching strategy. *Journal of Science Education and Technology*, 19(1), 32-48. <https://doi.org/10.1007/s10956-009-9176-0>
- Carkıt, C., (2013). *Assessment of grammar teaching process in secondary schools for constructivist approach* (Unpublished Master Thesis). Erciyes University, Turkey.
- Cheng, P. H., Yang, Y. T. C., Chang, S. H. G., & Kuo, F. R. R. (2015). 5E mobile inquiry learning approach for enhancing learning motivation and scientific inquiry ability of university students. *IEEE Transactions on Education*, 59(2), 147-153. <https://doi.org/10.1109/TE.2015.2467352>
- Ching, Y. S., Chaun, L. W. (2004) The Relationship among Creative, Critical Thinking and Thinking Styles in Taiwan High School Students. *Journal of Instructional Psychology*, 31(1), 33-45.
- Dewi, P. Y. A., & Primayana, K. H. (2019). Effect of learning module with setting contextual teaching and learning to increase the understanding of concepts. *International Journal of Education and Learning*, 1(1), 19-26. <https://doi.org/10.31763/ijele.v1i1.26>
- Din, M. (2020). Evaluating university students' critical thinking ability as reflected in their critical reading skill: A study at bachelor level in Pakistan. *Thinking Skills and Creativity*, 35, 100627. <https://doi.org/10.1016/j.tsc.2020.100627>
- Eisenkraft, A. (2003). Expanding the 5E Model. *Science Teacher* 70 (6): 56-59. Washington Copyright 2003. Published by the National Science Teachers Association
- Erdogan, F. (2019). Effect of cooperative learning supported by reflective thinking activities on students' critical thinking skills. *Eurasian journal of educational research*, 19(80), 89-112. <https://doi.org/10.14689/ejer.2019.80.5>
- Facione, P. (1990). *Critical thinking: A statement of expert consensus for purposes of educational assessment and instruction* (The Delphi Report).

- Gurbuz, F. (2012). *The effect 7e model on academic achievement and retention of knowledge in the unit of, Electricity in our Life' in 6th grade science and technology* (Unpublished doctoral thesis). Ataturk University, Turkey.
- Hand, B., Chen, Y. C., & Suh, J. K. (2021). Does a knowledge generation approach to learning benefit students? A systematic review of research on the science writing heuristic approach. *Educational Psychology Review*, 33(2), 535-577. <https://doi.org/10.1007/s10648-020-09550-0>
- Holmes, J., Guy, J., Kievit, R. A., Bryant, A., Mareva, S., Gathercole, S. E., & CALM Team. (2021). Cognitive dimensions of learning in children with problems in attention, learning, and memory. *Journal of Educational Psychology*, 113(7), 1454. <https://doi.org/10.1037/edu0000644>
- Jarvis, M. A., & Baloyi, O. B. (2020). Scaffolding in reflective journaling: A means to develop higher order thinking skills in undergraduate learners. *International Journal of Africa Nursing Sciences*, 12, 100195. <https://doi.org/10.1016/j.ijans.2020.100195>
- Karplus, R., & Their, H. D. (1967). *A new look at elementary school science*. Chicago: Rand McNally.
- Kaur, P., & Gakhar, A. (2014). 9E model and e-learning methodologies for the optimisation of teaching and learning. Paper presented at the 2014 *IEEE International Conference on MOOC, Innovation and Technology in Education (MITE)*. <https://doi.org/10.1109/MITE.2014.7020300>.
- Kramer, M. (2020). *More than a principal: A mixed methods exploration of successful high school leadership in the Western Cape, South Africa* (Doctoral dissertation, University of Oxford).
- Mahanal, S., Zubaidah, S., Sumiati, I. D., Sari, T. M., & Ismirawati, N. (2019). RICOSRE: A Learning Model to Develop Critical Thinking Skills for Students with Different Academic Abilities. *International Journal of Instruction*, 12(2), 417-434. <https://doi.org/10.29333/iji.2019.12227a>
- Malmia, W., Makatita, S. H., Lisaholit, S., Azwan, A., Magfirah, I., Tinggapi, H., & Umanailo, M. C. B. (2019). Problem-based learning as an effort to improve student learning outcomes. *Int. J. Sci. Technol. Res*, 8(9), 1140-1143.
- Morris, T. H. (2019). Self-directed learning: A fundamental competence in a rapidly changing world. *International Review of Education*, 65(4), 633-653. <https://doi.org/10.1007/s11159-019-09793-2>
- Paul, R., & Elder, L. (2019). *The miniature guide to critical thinking concepts and tools*. Rowman & Littlefield.
- Putri, A., Roza, Y., & Maimunah, M. (2020). Development of learning tools with the discovery learning model to improve the critical thinking ability of mathematics. *Journal of Educational Sciences*, 4(1), 83-92. <https://doi.org/10.31258/jes.4.1.p.83-92>
- Sahin, H., (2014). The reflections of the constructivist approach to science teaching. *Mehmet Akif Ersoy University Journal of Education Faculty, Issue 29*, 151- 170.
- Sokhanvar, Z., Salehi, K., & Sokhanvar, F. (2021). Advantages of authentic assessment for improving the learning experience and employability skills of higher education students: A systematic literature review. *Studies in Educational Evaluation*, 70, 101030. <https://doi.org/10.1016/j.stueduc.2021.101030>
- Suhendi, A. (2018). Constructivist learning theory: The contribution to foreign language learning and teaching. *KnE Social Sciences*, 87-95. <https://doi.org/10.18502/kss.v3i4.1921>
- Wahyuni, S., Sanjaya, I. G. M., Erman, E., & Jatmiko, B. (2019). Edmodo-based blended learning model as an alternative of science learning to motivate and improve junior high school students' scientific critical thinking skills. *International Journal of Emerging Technologies in Learning (Online)*, 14(7), 98. <https://doi.org/10.3991/ijet.v14i07.9980>
- Wei, B., Lin, J., Chen, S., & Chen, Y. (2022). Integrating 21st century competencies into a K-12 curriculum reform in Macau. *Asia Pacific Journal of Education*, 42(2), 290-304. <https://doi.org/10.1080/02188791.2020.1824893>
- Yerdelen, S., (2013). *The effect of the instruction based on the epistemologically and metacognitively improved 7E learning cycle on tenth grade students' achievement and epistemological understandings in physics* (Unpublished doctoral thesis). Middle East Technical University, Turkey.
- Zhong, B., & Xia, L. (2020). A systematic review on exploring the potential of educational robotics in mathematics education. *International Journal of Science and Mathematics Education*, 18(1), 79-101 <https://doi.org/10.1007/s10763-018-09939-y>

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