

Original Article

Predicting the Relationship between Learning Style and Critical Thinking Skills with the Mediating Role of Distance Education Technologies in Students of Payam Noor University**Maryam Ansary*¹, Lale Yalame², Azam Bakhtyari Renani³**

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Abstract

Critical thinking in students' education is associated with the analysis of received information. Students provide the basis for the development of critical thinking in their future careers by cultivating this skill. This study is conducted to predict the relationship between learning style and critical thinking skills with the mediating role of distance education technologies in students of Payam Noor University. This is an applied study in terms of objectives and also a descriptive-correlational one since it describes the existing situation. The statistical population includes 253 distance learning students of Payam Noor University in Chaharmahal and Bakhtiari Province, of which 153 were selected as samples using the Cochran formula and simple random sampling. The population was asked to answer the Kolb Learning Style Inventory (12 questions), the California Critical Thinking Skills Test (CCTST) (24 questions), and the researcher-made distance education technology questionnaire (10 questions). Due to the standard questions of the questionnaires, it could be argued that they are highly valid. The reliability of the questionnaires was checked through Cronbach's alpha using SPSS software, and it was found that all three questionnaires were sufficiently reliable. The data were analyzed using SPSS, and structural equation modeling (SEM) was used to test the hypotheses using LISREL software. The results showed that the development of critical thinking skills to select, analyze, and apply information to solve problems in everyday life should be the focus of education and training systems in this era rather than inventing and applying methods of memorizing and processing information in memory.

Keywords

learning style, critical thinking skills, distance education technologies, students of Payam Noor University.

Introduction

As the ability to think clearly and logically and understand the relationship between ideas, critical thinking has existed since the time of the early Greek philosophers such as Plato and Socrates until the modern era. This skill has many benefits such as discussion and thinking to solve problems and the ability to detect fake news. This thinking makes you use your ability to reason, that is, to be an active rather than passive receiver of information. Critical thinkers question the existing ideas and assumptions rather than accepting information quickly. They are always looking to determine whether ideas, arguments, and findings represent the overall picture of reality and, if not, are ready to accept it. Critical thinking refers to a way of thinking about a specific situation at a specific time. Like learning the multiplication table, critical thinking is not an accumulation of facts and knowledge that you can learn once and use forever. Critical thinking skills enable you to understand and address a situation based on all available facts and information. When using these skills, you arrange and organize facts, data, and other information to describe a problem and find effective solutions to it. This study aims

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to investigate how learning mechanisms can affect critical thinking skills and what role distance education technology plays in this relationship.

Nowadays, teaching-learning is facilitated in any part of the world due to access to the Internet and various digital education software. New teaching-learning technologies, including distance education, have removed the barriers of climate, geography, age, and gender for higher education. Learning and cultivating critical thinking skills is at the heart of the educational system, and cultivating students' critical thinking skills is one of the goals of the higher education system.

Everyone is aware of the role of universities in establishing a modern and advanced society. In this regard, paying attention to educating active, responsible, and democratic people, solving cultural, social, economic, and industrial problems, and helping to promote science and expand the boundaries of science are on the agenda of almost all universities and higher education institutions around the world (Anvar Shah Mohammadi, 2019).

Kliment & Kabrilana suggest that the foundation of the political-economic development of societies is based on universities and higher education institutions because higher education systems are, on the one hand, the preservers and transmitters of cultural heritage and society's values, and on the other hand, respond to new social needs considering the growth of modern knowledge and technology (Fitzpatrick et al., 2011). However, the new systems are no longer limited to ordinary classes not only due to paradigm changes in the economic and technological fields and the emergence of macro trends but also due to the expansion of higher education (Azizi, 2013).

A clear example of the capabilities of ICT in providing flexible and extensive training is the virtual university, which is expanding in many countries. One of the important goals of higher education in the use of ICT in classrooms is to enable students to be more involved in the teaching-learning process. Students should have progressive training according to the developments of the information age to have the necessary qualifications to properly face the surrounding phenomena and make the best decisions so that they can play an effective role at different levels of society. Some of the results of the expansion of ICT and the provision of virtual education are facilitating the participation and involvement of students and developing their critical thinking skills. The presence of critical thinking in classrooms is the turning point of the teaching-learning process. As a high-level cognitive ability, critical thinking contributes to the decision-making process in personal and general life. It teaches learners that not only should they learn general knowledge but also the application of this knowledge is useful for them. It could be argued that one of the important tasks of higher education is to promote students' critical thinking. Schools and higher education should take advantage of various instrumental interventions to promote students' critical skills (Niu et al., 2013).

One of the most vital skills in today's society is critical thinking, the lack of which suppresses independence and creates anxiety when facing unfamiliar situations, increases errors, and causes a lack of effective participation in society (Barkhordari, 2009). So, education, especially higher education, should provide opportunities for learners in such a way that they can evaluate new knowledge and the vast amount of information that they face while doing their intellectual activities. It is agreed by most of the experts that critical thinking provides the basis for students to develop the skills of evaluating new knowledge and technology. Education in the contemporary era should focus more than in the past on the process and thinking skills of critical thinking rather than the content (Sezar, 2008).

Learning style refers to the way people process information and adopt new strategies for effective learning. Each person has different recognizable and relatively stable preferred methods for understanding, organizing, and storing information. People use their knowledge and learning to adapt and monitor the situation. In this way, their different learning styles appear (Artours, 2007).

Considering the importance of learning and developing students' critical thinking skills, the study seeks to identify the relationship between learning mechanisms and critical thinking skills with the mediating role of modern distance education technologies in students of Payam Noor University.

Objectives

The main objective of the study is to predict the relationship between the learning mechanism and critical thinking skills with the mediating role of distance education technologies in students of Payam Noor University.

Hypotheses

The hypotheses of the study are as follows:

- There is a relationship between learning mechanisms and critical thinking skills.
- There is a relationship between learning mechanisms and distance education technologies.
- There is a relationship between distance learning technologies and critical thinking skills.
- Distance education technologies play a mediating role in the relationship between learning mechanisms and critical thinking skills.

Literature Review

Here are some domestic and foreign studies concerning the subject under review.

Turkzadeh et al. (2021) conducted a study to determine critical thinking indicators in the teaching-learning process in Iran based on grounded theory with a systematic approach attributed to Strauss and Corbin and paradigmatic logic. Since critical thinking is an important outcome of education, more studies should be conducted and reliable and valid tools should be continuously developed to measure students' critical thinking to guide teaching strategies that effectively facilitate critical thinking among students.

Zolfaghari (2019) conducted a study titled *The Effectiveness of Metacognitive Strategies of SQP4R on Critical Thinking of Distance Education Students*. This was a quasi-experimental study with a pretest-posttest design and a control group. The population included all distance education students of Payam Noor University in Hamedan Province in the academic year 2018-2019, of which 30 people were randomly selected as a sample using convenient sampling and randomly assigned to the experimental and control groups (15 in each group). The findings showed that teaching metacognitive strategies affected students' critical thinking ($p > 0.01$). Teaching metacognitive strategies could be used to increase students' critical thinking.

Ahmadbegi et al. (2019) conducted a study titled *The Effectiveness of Critical Thinking Training on Problem-Solving Practices in Students*. This was an applied study in terms of objectives and a quasi-experimental one with a pretest-posttest design and a control and follow-up group in terms of data collection method. It can be acknowledged that students' ability to solve problems will improve with the development of critical thinking levels as a capability that affects problem-solving. So, attention should be paid to teaching critical thinking to increase students' ability to solve problems, and courses in this regard should be held in educational centers, especially universities and higher education centers. The findings showed that critical thinking training affects students' problem-solving skills and that this effect is stable over time.

Majidian Fard et al. (2018) conducted a study titled *Investigating the Structural Relationship (Development of a Model) of Critical Thinking Based on Learning Styles and the Mediating Role of Metacognition*. This was a correlational study conducted with a quantitative method. The participants included 322 students of AJA University of Medical Sciences who were selected by stratified random sampling. The findings showed that there is a significant relationship between abstract learning style and critical thinking with the

mediating role of metacognition at the level of $p < 0.01$. However, there is no significant relationship between objective learning style and critical thinking with the mediating role of metacognition.

Mahrozadeh et al. (2016) conducted a study titled *Examining People's Learning Styles and the Relationship between the Priority of Styles and Their Tendency to Think Critically*. The results suggested that people with critical thinking skills and awareness of their learning style can increase their efficiency in transforming the surrounding environment. We will not necessarily have critical thinking by choosing the desired cognitive styles, for example, a context-independent learning style, but we can try to create and cultivate critical thinking to achieve this goal. Faculty members, teachers, and education practitioners are recommended to consider students' learning styles and try to cultivate their critical thinking skills by applying new educational approaches and procedures.

Choon et al. (2021) conducted a study titled *Distance Education During the COVID-19 Pandemic: The Effects of Problem-Based Learning on Improving Students' Critical Thinking and Problem-Solving Skills*. They designed a problem-based learning (PBL) unit module using distance learning to examine students' experiences in PBL and determine the extent to which the PBL module helps students improve their critical thinking and problem-solving skills. The results showed that students' critical thinking and problem-solving skills improved significantly after distance learning PBL.

Supriyatno et al. (2020) conducted a study titled *E-Learning Development in Improving Students' Critical Thinking Ability to discover authentic e-learning media*. The objective of the study was to improve critical thinking skills, gain a high-level overview, and increase students' critical thinking skills.

Affandy et al. (2019) conducted a study titled *The Correlation of Character Education with Critical Thinking Skills as an Important Attribute to Success in the 21st Century*. The tool used was a critical thinking skill test using 4 items from the national test, personality training, questionnaire, and focus group discussion (FGD). The results indicated that the nature of learning lies not only in the students' learning outcomes, but is a continuous process including cognitive, emotional, and psychomotor aspects. In the learning process, students are allowed to be actively involved in such a way that their critiques are strengthened. Critical thinking skills are among the essential skills for success in the 21st century. The results also showed that there is a relationship between critical thinking skills and students' personality values.

Dilekli (2017) conducted a study titled *The Relationship Between Critical Thinking Skills and Learning Styles of Gifted Students*. The participants were 9-15 years old and studied in middle and high schools. The data was collected using the Kolb Learning Style Inventory and the Critical Thinking Scale. The findings showed that gender is not a significant variable for learning styles but it is for critical thinking skills. Gifted students had high scores on the Critical Thinking Scale. Moreover, there was a relationship between the learning styles of gifted students and their critical thinking skills, except in the analysis dimension of the critical thinking scale.

Theoretical Framework

This study was conducted mainly to predict the relationship between learning style and critical thinking skills with the mediating role of distance education technologies in students of Payam Noor University. The conceptual model is as follows (Figure 1).

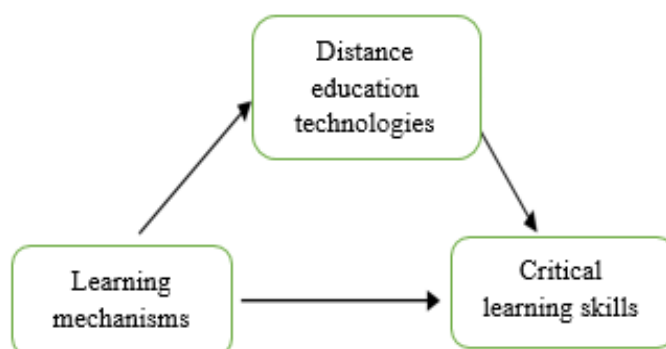


Figure1. The conceptual model

Methodology

This is an applied study in terms of objectives and also a descriptive-correlational one since it describes the existing situation.

The statistical population includes 253 distance learning students of Payam Noor University in Chaharmahal and Bakhtiari Province, of which 153 were selected as samples using the Cochran formula and simple random sampling. The data were collected by field method and through questionnaires, which are designed in two parts:

The first part includes the general and demographic characteristics of the respondents (gender, age, and marital status), and the second part includes specialized questions. The Kolb Learning Style Inventory (12 questions), the California Critical Thinking Skills Test (CCTST) (24 questions), and the researcher-made distance education technology questionnaire (10 questions) were used in the study. Due to the standard questions of the questionnaires, it could be argued that they are highly valid. The content validity of the study was obtained through expert approval after necessary modifications. An initial sample consisting of 30 pre-test questionnaires was distributed to measure the reliability of the questionnaires. The reliability of the questionnaires was then calculated through Cronbach's alpha using SPSS 22. The reliability coefficients of the questionnaires were 0.87 for the learning mechanism, 0.88 for critical thinking skills, and 0.89 for distance education technologies, indicating the reliability of the questionnaires. The data were analyzed using descriptive and inferential statistics. Descriptive statistics in the form of tables, measures of central tendency, and graphs were used to describe the sample's demographic information using SPSS. Structural equation modeling (SEM) was used for inferential statistics using LISREL. SEM is typically a combination of measurement and structural models.

Findings

Descriptive Findings

In this section, respondents are examined based on three variables gender, education level, and marital status. Bar graphs are used to better explain the situation of the population.

Table 1 shows the population frequency in terms of gender, education level, and marital status.

Table 1. General and demographic characteristics

	Gender		Marital status		Education level		
	Female	Male	Married	Single	Associate degree	Bachelor's degree	Master's degree
Frequency	122	31	40	113	34	96	23
Percentage	79.7	20.3					
Relative frequency			26.3	73.9	22.2	62.8	15
Total	153						

As seen in Table 1, 20.3% of the population are male and 79.7% are female. Additionally, 26.3% are married and 73.9% are single. 22.2% have an associate's degree, 62.8% have a bachelor's degree, and 15% have a master's degree or higher.

Measures of Central Tendency and Dispersion

Measures of central tendency and dispersion are shown in Table 2.

Table 2. Measures of central tendency and dispersion of the variables

Variable	Mean	SD
Learning mechanisms	3.1	1.26
Critical thinking skills	3.2	1.17
Distance education technologies	3.4	0.52

Inferential Findings

Normal Distribution of Data

One of the common criteria for evaluating the normal distribution of data is the Kolmogorov–Smirnov test, which is based on the difference between the relative cumulative frequency of observations and the expected value under the null hypothesis. The null hypothesis suggests that the data has a normal, Poisson, exponential, or uniform distribution. In this test, the null hypothesis is rejected if the P-value is less than 0.05. This means that the data cannot follow a particular distribution such as normal, Poisson, exponential, or uniform. According to Table 3, the P-value is greater than 0.05 in all constructs. Therefore, there is no reason to reject the hypothesis that the data have a normal distribution.

Table 3. The normality test

Variable	The Kolmogorov-Smirnov test	P-value
Learning mechanisms	0.489	0.834
Critical thinking skills	0.749	0.701
Distance education technologies	0.601	0.901

Measurement Model

In this section, confirmatory factor analysis (CFA) is performed to measure the models using LISREL software. The T-value of a coefficient in the measurement model must be greater than 1.96 for it to be significant. The T-value indicates the significance of each observed variable. The blue color in the software indicates significance and the red color indicates non-significance, in

which case the relationship should be removed. Fitness and unfitness of the indicators (questions), variables, and concepts can be generally tested according to standard coefficients and T-values. The measurement model for constructs in Standardized Solution and T-value modes can be seen in Figures 2 and 3. Part of the goodness of fit of the model is as follows:

Degrees of Freedom	355
Normal Theory Weighted Least Squares Chi-Square	973.14
Root Mean Square Error of Approximation (RMSEA)	0.069
Non-Normed Fit Index (NNFI)	0.92
Comparative Fit Index (CFI)	0.93
Incremental Fit Index (IFI)	0.93
Goodness of Fit Index (GFI)	0.75

According to the table above, the chi-square value is 973.14 and the degree of freedom is 355. So, the ratio of chi-square to the degree of freedom is 2.74, which is less than 3. So, it is fit. Besides, the value of RMSEA is 0.08 and thus acceptable, and the P-value is 0.0000, which is unfit since it is not more than 0.05. However, the low P-value is not a concern because this value is sensitive to the sample size and the RMSEA statistic is significant.

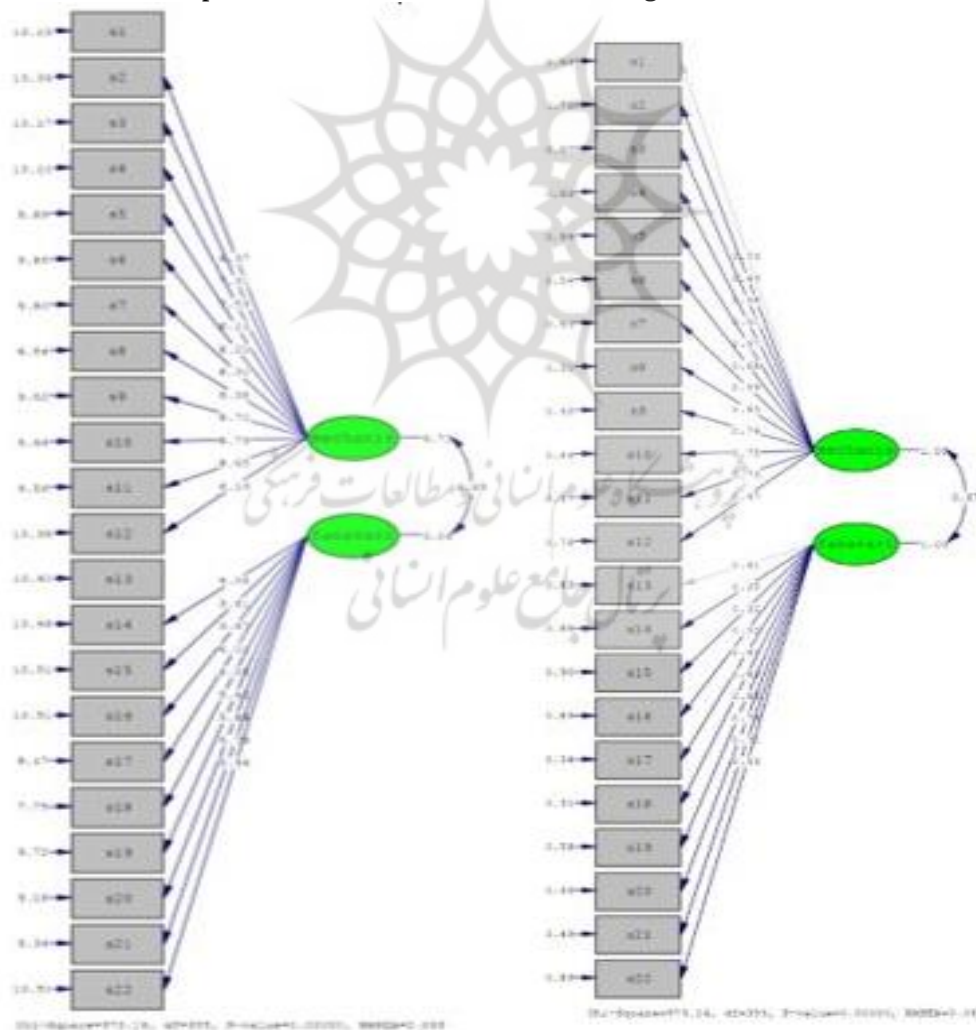
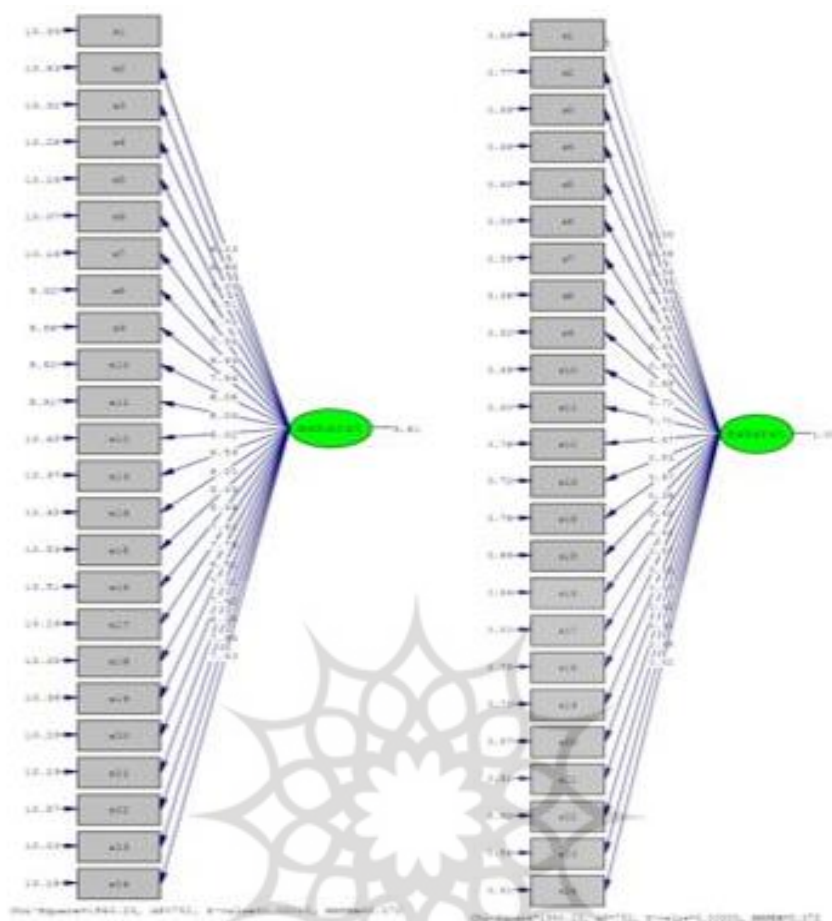


Figure 2. The measurement model (standard)

Figure 3. The measurement model (significance)

**Figure 3.** The measurement model (standard)**Figure 4.** The measurement model (significance)

The factor loadings of the observed variables on the latent variables in the standard mode can be seen in Tables 4 to 6.

Table 4. CFA (learning mechanisms)

Items	Standard	Significance
Q1	0.59	
Q2	0.49	6.37
Q3	0.58	7.31
Q4	0.61	7.59
Q5	0.67	8.13
Q6	0.68	8.20
Q7	0.69	8.30
Q8	0.83	9.38
Q9	0.74	8.70
Q10	0.75	8.79
Q11	0.73	8.65
Q12	0.47	6.19

Table 5. CFA (distance education technologies)

Items	Standard	Significance
Q1	0.41	
Q2	0.35	4.08
Q3	0.32	3.81
Q4	0.32	3.87
Q5	0.81	6.01
Q6	0.83	6.05
Q7	0.65	5.62
Q8	0.73	5.84
Q9	0.71	5.79
Q10	0.33	3.94

Table 6. CFA (critical thinking skills)

Items	Standard	Significance	Q13	0.53	6.52
Q1	0.55		Q14	0.47	6.59
Q2	0.48	6.13	Q15	0.38	6.00
Q3	0.56	6.86	Q16	0.40	5.09
Q4	0.58	7.06	Q17	0.62	5.34
Q5	0.3	7.51	Q18	0.67	7.41
Q6	0.66	7.75	Q19	0.52	7.79
Q7	0.64	7.56	Q20	0.57	6.51
Q8	0.80	8.66	Q21	0.62	7.01
Q9	0.69	7.94	Q22	0.31	7.42
Q10	0.71	8.08	Q23	0.68	4.26
Q11	0.71	8.06	Q24	0.62	7.84
Q12	0.47	6.02			

As can be seen, all factor loadings are greater than 1.96. So, the relationships are significant, and all the questions explain their related constructs.

The Structural Model

According to the hypotheses and the conceptual model, the structural model in significant (T-value) and standard modes can be seen in Figures 5 and 6. In the case of significance, wherever the absolute value of all the numbers is greater than 1.96, the relationship is significant and otherwise insignificant.

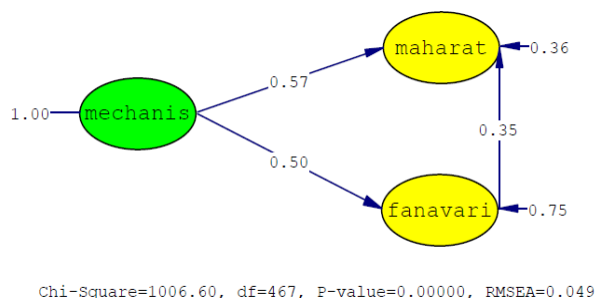


Figure 5. The structural model (standard) Figure

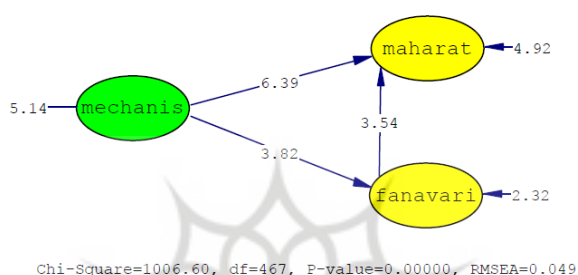


Figure 6. The structural model (significance)

Considering the factor loadings between the main constructs of the model, it is concluded that all are significant. Also, since the inclusive value of the variance is 0.23, distance education technologies play a partial mediating role in the relationship between learning mechanisms and critical thinking skills. Table 7 shows the results of the structural model.

Table 7. The results of the structural model

Variable	Distance education technologies		Critical thinking skills	
	Standard	Significance	Standard	Significance
Learning mechanisms	0.50	3.82	0.57	6.39
Distance education technologies			0.35	3.54

Conclusion

Any study is a logical, organized, and scientific attempt to arrive at an answer to a question or a solution to it. To achieve the solutions that are the main objectives of a study, a path must be taken, the way it is taken depends on various factors such as the nature of the problem, question, etc. Each path is a process that consists of steps. The results are very important in this process because they can provide a basis for solving problems or improving the existing situation and pave the way to reach the desired situation. The results of the test of the study hypotheses are as follows:

- There is a relationship between learning mechanisms and critical thinking skills.

Mahrozadeh et al. (2016) conducted a study titled Examining People's Learning Styles and the Relationship between the Priority of Styles and Their Tendency to Think Critically. The results suggested that people with critical thinking skills and awareness of their learning style can

increase their efficiency in transforming the surrounding environment. Thus, the results of this study are in line with the results of the present study.

In explaining the above results, it could be argued that the development of critical thinking skills to select, analyze, and apply information to solve problems in everyday life should be the focus of education and training systems in this era rather than inventing and applying methods of memorizing and processing information in memory. As a level of thinking, critical thinking can be taught and developed. This level of thinking can be developed using new and practical methods in education. In the following, the results of other studies are compared with the results of this study.

- There is a relationship between learning mechanisms and distance education technologies.

Al-Qahtani et al. (2021) conducted a study titled Virtual Education During COVID-19. They investigated the factors concerning satisfaction with e-learning among Saudi nursing students. The results indicated that previous experiences and preparation for e-learning affected students' overall satisfaction with e-learning and that preparation for e-learning was associated with satisfaction with teaching, general skills, and learning experiences.

Jazini (2018) conducted a study titled The Effect of Virtual Education Courses of Universities and Non-Profit Institutions on Knowledge Development. The results showed that virtual education courses affect knowledge development in terms of content, organization of educational materials, flexibility, workload, methods of evaluation of elements of teaching-learning activities, feedback provided, and assisting and motivating students. The results also suggested that the use of ICT and the development of virtual education in the studied institution affect the learning and teaching of students.

In explaining the above results, it can be stated that hard technologies as accessible and tangible tools and soft technologies as a set of ideas, plans, innovations, and initiatives crystallized in educational design, determining and planning approaches and educational models dramatically increase the teaching effect and improve student learning. The type and way of thinking have a special place in modern education, and technologies have allowed learners to be equipped with knowledge and skills so that they do not get stuck in the face of everyday challenges. As hard technologies, education technologies alone do not have value but are validated by soft technologies.

- There is a relationship between distance learning technologies and critical thinking skills.

Supriyatno et al. (2020) conducted a study titled E-Learning Development in Improving Students' Critical Thinking Ability to discover authentic e-learning media. The objective of the study was to improve critical thinking skills, gain a high-level overview, and increase students' critical thinking skills.

In explaining the above results, it can be argued that more efforts should be made to implement and better understand distance education technologies. So, the Ministry of Education should review the goals, content, educational materials, teaching-learning methods, learning mechanisms, and everything concerning the curriculum area.

It is worth noting that formal and superficial changes will not work in curriculum revision and that logical fundamental changes are needed in all curriculum processes. Some obstacles to improving and cultivating critical thinking are incorrect learning methods, intensive training programs, limited class time, passive teaching methods, and memorization-based evaluations that measure low levels of cognitive skills. So, researchers recommend the coherent and integrated inclusion of critical thinking throughout the curriculum, which requires rethinking, common thinking, and the discourse of education experts, planners, practitioners, and teachers.

- Distance education technologies play a mediating role in the relationship between learning mechanisms and critical thinking skills.

According to Duran and Dökme (2016), science and technology learning significantly affects students' critical thinking skills in science and technology courses by supporting guided activities

developed in line with the IBL approach. So, the results of this study are consistent with the results of the present study.

In explaining these results, it could be suggested that distance education can affect critical thinking and cause learning styles to affect critical thinking skills more. Thus, critical thinking in schools can be improved by equipping distance education infrastructure. Learning can promote critical thinking in students through distance learning technologies.

Practical Recommendations

- It is recommended to organize in-service courses on new learning styles for teachers to affect students' critical thinking skills.
- Virtual universities are recommended to be equipped with new educational technologies.
- The use of critical thinking questionnaires is recommended to measure students' critical thinking skills over a period.
- Conducting workshops on how to deal with students with different learning styles in classrooms leads to recognition of the individual differences of students by teachers and dealing with them appropriately.
- The educational content is recommended to be designed to strengthen the students' critical thinking and improve their learning style.

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