*Corresponding Author's Email: nenad.djokic@ef.uns.ac.rs
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Intelligent Tutoring Systems and Distance Education – Students Perceptions

Nenad Djokic*, Nikola Milicevic and Ines Djokic
University of Novi Sad, Faculty of Economics in Subotica, Department of Trade, Marketing and Logistics, Republic of Serbia

Abstract

Technology development has brought many changes in the educational sector; among them are those related to distance education. Although established centuries ago, the need for this form of education was particularly pronounced during the coronavirus pandemic. Since then, different types of tools and techniques have been developed and improved to support the interaction between teachers and their students. Some of those platforms are based on the implementation of artificial intelligence technology. As the most common application based on AI, intelligent tutoring systems provide students with an adjusted and personalized approach to learning. To introduce these systems in education, it is necessary to investigate the perceptions of their main clients, i.e., students. Accordingly, the paper examines the levels of mentioned perceptions, taking into account students' gender and AI anxiety. For this purpose, we applied an online questionnaire. The research was conducted on a convenience sample of 285 students. After testing the scales' reliability and validity, independent samples t-test and Pearson correlation were used. The results pointed to the existence of relatively positive perceptions towards the intelligent tutoring systems. In addition, no significant difference in students' perceptions regarding ITS from the aspect of gender, nor a significant relationship between those perceptions and AI anxiety was found.

Keywords: artificial intelligence, distance education, intelligent tutoring systems, students

1. Introduction

The spread of coronavirus (COVID-19) has brought many changes in almost all aspects of human life, including education. During the pandemic, most cities were using distance learning to ensure the continuity of the educational process (Aljarrah et al., 2021). Although that period is over, this type of education is still applied by many institutions.

The beginnings of distance education are related to the study opportunity "Composition through the medium of the Post", which was advertised in a Swedish newspaper in the 1800s (Saykılı, 2018). Since then, there have been many definitions and explanations regarding this

term. Two main characteristics, i.e., two constituent elements of distance education, refer to the mediation of subject-matter presentation and the mediation of the interaction between tutors and their students (Holmberg, 2003). It can be defined as "an educational mode of systematic teaching and communication between learners and teachers or between learners and educational institutions by means of a series of media forms" (Ji et al., 2023, p. 45) or as an educational activity associated with the effective transmission of the curriculum to students (learners) in places outside the educational institution classrooms (Ji et al., 2023).

Although the application of distance education brings many benefits to students (such as the possibility to study at work or at the desired time), it still represents a new learning approach, which requires certain accommodations from both teachers and students (Fojtík, 2018). One of the factors that can facilitate the application of distance education relates to technology. Among its different types, in today's digital conditions, special attention should be dedicated to artificial intelligence (AI). Several AI tools and techniques are created for educational purposes, and some of them have already been applied in certain institutions. The intelligent tutoring systems (ITS) based on AI technology represent a solution that can improve the process of distance education, especially when it comes to online learning (St-Hilaire et al., 2022). Hereby, this paper deals with the ITS systems and the level of students' perceptions towards them. Additionally, those perceptions were analyzed in the context of gender and AI anxiety (AIA). The obtained results were followed by discussion and conclusions.

2. Literature review

Some practical experiences have shown that distance education has proved to be a very demanding form of education (Fojtík, 2018). For students, the main issues are (Fojtík, 2018):

- limitation concerning personal contact with teachers and colleagues,
- the lack of traditional lecturers and seminars,
- infrequent and poor communication with tutors,
- omissions during the self-study process,
- time organization problems,
- problems in comprehending some terms,
- difficulties in retaining study motivation.

On the other hand, teachers are confronted with the issues associated with a lack of experience, difficult and challenging preparations, the necessity for systematic technical security, etc. (Fojtík, 2018). The application of AI technology can be useful in solving some of those problems. With its effective involvement, modern distance education activities can become more (Ji et al., 2023):

- efficient (the rational implementation of artificial intelligence in distance education contributes to time savings and teaching quality),
- accurate (the use of AI technology allows deeper insights into students' learning behavior, enabling teachers to understand their conditions and react properly),
- realistic (with the application of artificial technology, distance teaching situations may become more authentic, which improves interactivity and teaching attractiveness).

The most common applications of artificial intelligence in education refer to intelligent tutoring systems (Holmes and Tuomi, 2022). These learning systems, powered by AI, ensure adaptive and personalized guidelines and tutorials for students (Holmes and Tuomi, 2022;

Lin et al., 2023). Intelligent tutoring systems are able to deal with "such personalization factors as individual student characteristics and cognitive processes, and provide personalized feedback and interactions, or even develop personalized curriculum and generate personalized feedback" (St-Hilaire et al., 2022, p. 2). Spark and Gooru are just some examples of ITSs (Holmes and Tuomi, 2022).

From the perspective of students, following Cheng et al. (2023), intelligent tutoring systems represent the first of the eight important domains considering their conceptions of artificial intelligence in education. Their perceptions towards the use of AI in education (including all eight domains) have already been examined by Djokic et al. (2024).

Karaci et al. (2018) investigated university student's perceptions regarding web-based intelligent tutoring systems. The focus of their research was on the acceptance of the mentioned ITS, which 38 students had been using for four weeks. After understanding the flexibility and possibilities of the ITS, some of the students even changed their attitudes concerning online learning. The acceptance of ITS was analyzed among high school students as well. For this purpose, Huang et al. (2022) recruited 102 participants from a private education training institution. Hereby, the ITS used in their research was intended to provide homework and guidelines for learning mathematics. Similarly, Adelana and Akinyemi (2021) examined the awareness and readiness to use the AI-based tutoring system, taking into account senior secondary school students.

When it comes to students' perceptions of ITS and AI technology in general, an important factor may be the level of their anxiety. AI anxiety, which can be defined as "feelings of fear or agitation about out-of-control AI" (Wang and Wang, 2022, p. 622), has already been applied in several studies concerning artificial intelligence among the student population (Kwak et al., 2022; Wang et al., 2022). Additionally, AI learning anxiety was found to have a significant effect on both positive and negative general attitudes toward artificial intelligence subscale (Kaya et al., 2024).

3. Research Methodology

This study examined students' perceptions regarding intelligent tutoring systems in the context of gender and AI anxiety. For its purpose, we used an online questionnaire, which besides statements related to students' perceptions included certain demographic characteristics. Hereby, all items applied in the research were evaluated on a 5-point Likert scale.

For measuring perceptions towards ITS, we applied the scale proposed by Cheng et al. (2023), which consists of the three following items:

- ITS1 – Artificial intelligence used in tutoring is useful for providing a real-time diagnosis of my learning state.
- ITS 2 – Artificial intelligence in instruction is useful for assigning learning tasks based on my learning state.
- ITS 3 – Artificial intelligence in tutoring is useful for offering timely feedback on my learning.

It is important to mention that those items (ITS1, ITS2, and ITS3) were adapted and formulated as conditional statements.

Concerning AI anxiety, we used four items from the research of Venkatesh et al. (2003), and adjusted them in the context of artificial intelligence:

- AIA1 – I feel apprehensive about using the artificial intelligence
- AIA2 – It scares me to think that I could lose a lot of information using artificial intelligence by hitting the wrong key.
- AIA3 – I hesitate to use artificial intelligence for fear of making mistakes I cannot correct.
- AIA4 – Artificial intelligence is somewhat intimidating to me.

Our convenience sample included 285 respondents (students); about 55% of them were females. Data collection was carried out in 2023, and they were processed using the SPSS software. Reliability and validity were tested by using Cronbach's alpha coefficient and factor analysis. Both scales were presented through average values. In addition, perceptions regarding ITS (ITSav) were analyzed from the aspect of gender. To test this difference, we applied an independent samples t-test. Finally, the Pearson correlation between the two scales was performed.

4. Results

Scales for measuring students' perceptions were first tested in regard to reliability and validity. As the value of Cronbach's alpha coefficient was above 0.7 for both scales (α = 0.912 for the ITS scale and α = 0.930 for the AIA scale), it can be concluded that they were reliable. In addition, as can be seen in Tables 1 and 2 (separately for the ITS and AIA scales), the elimination of any of the used items wouldn't lead to an increase in Cronbach's alpha coefficient.

Table 1: Item-total statistics – ITS scale

ITS Scale				
	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
ITS1	7.5263	4.905	0.786	0.904
ITS2	7.4421	4.522	0.853	0.849
ITS3	7.3263	4.833	0.834	0.866

Source: Authors' own analysis

Table 2: Item-total statistics – AIA scale

AIA Scale				
	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
AIA1	8.6281	14.939	0.811	0.917
AIA2	8.6351	15.120	0.835	0.909
AIA3	8.6737	14.868	0.865	0.899
AIA4	8.4000	14.818	0.832	0.910

Source: Authors' own analysis

When it comes to factor analysis, the obtained results of the Kaiser-Meyer-Olkin Measure of Sampling Adequacy were satisfactory, while the p-values of Bartlett test sphericity were below 0.01. Those values are presented in Tables 3 and 4.

Table 3: KMO and Bartlett's Test – ITS scale

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.747
Bartlett's Test of Sphericity	Approx. Chi-Square	597.097
	df	3
	Sig.	0.000

Source: Authors' own analysis

Table 4: KMO and Bartlett's Test – AIA scale

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.817
Bartlett's Test of Sphericity	Approx. Chi-Square	961.033
	df	6
	Sig.	0.000

Source: Authors' own analysis

Results presented in Table 5 indicate the extraction of one factor that explains 77.880% of the variance, and those presented in Table 6 indicate the extraction of one factor that explains 76.697% of the variance.

Table 5: Total variance explained – ITS scale

Factor	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Var.	Cum. %	Total	% of Var.	Cum. %
1	2.553	85.103	85.103	2.336	77.880	77.880
2	0.276	9.192	94.295			
3	0.171	5.705	100.000			

Source: Authors' own analysis

Table 6: Total variance explained – AIA scale

Factor	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Var.	Cum. %	Total	% of Var.	Cum. %
1	3.306	82.641	82.641	3.068	76.697	76.697
2	0.347	8.671	91.312			
3	0.211	5.270	96.582			
4	0.137	3.418	100.000			

Source: Authors' own analysis

In addition, both scales were tested together within factor analysis. As can be seen in Table 7, the results of KMO and Bartlett's Test were satisfactory.

Table 7: KMO and Bartlett's Test – Both scales

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.788
Bartlett's Test of Sphericity	Approx. Chi-Square	1567.269
	df	21
	Sig.	0.000

Source: Authors' own analysis

Table 8 points to the extraction of two factors, whereas they explained 77.293% of the variance.

Table 8: Total variance explained – Both scales

Factor	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Var.	Cum. %	Total	% of Var.	Cum. %
1	3.343	47.755	47.755	3.104	44.347	44.347
2	2.521	36.008	83.764	2.306	32.947	77.293
3	0.354	5.054	88.818			
4	0.278	3.971	92.789			
5	0.203	2.904	95.693			
6	0.169	2.419	98.112			
7	0.132	1.888	100.000			

Source: Authors' own analysis

Table 9 indicates that there are loadings of items belonging to different scales into two

factors. Hence, we can see the conformation of discriminant validity.

Table 9: Rotated factor matrix

	Factor	
	1	2
ITS1	-0.027	**0.827**
ITS2	-0.021	**0.924**
ITS3	-0.036	**0.893**
AIA1	**0.823**	-0.027
AIA2	**0.898**	-0.046
AIA3	**0.930**	0.025
AIA4	**0.847**	-0.062

Source: Authors' own analysis

Concerning the levels of students' perceptions of ITS, the mean value for all three items was above 3.5 (Table 10).

Table 10: Descriptive statistics – ITS items

	N	Mean	Std. Deviation	Min	Max
ITS1	285	3.6211	1.15227	1.00	5.00
ITS2	285	3.7053	1.18862	1.00	5.00
ITS3	285	3.8211	1.12881	1.00	5.00
ITSav	285	3.7158	1.06697	1.00	5.00

Source: Authors' own analysis

In the case of AI anxiety, mean values exceeded 3 only in the case of item AIA4 (Table 11).

Table 11: Descriptive statistics – AIA items

	N	Mean	Std. Deviation	Min	Max
AIA1	285	2.8175	1.42971	1.00	5.00
AIA2	285	2.8105	1.37606	1.00	5.00
AIA3	285	2.7719	1.37658	1.00	5.00
AIA4	285	3.0456	1.42217	1.00	5.00
AIAav	285	2.8614	1.27341	1.00	5.00

Source: Authors' own analysis

The total average value of students' perceptions regarding ITS (ITSav) was analyzed from the aspect of gender. Its mean levels for males and females are presented in Table 12.

Table 12: Descriptive statistics – gender aspect

	Gender	N	Mean	Std. Deviation	Std. Error Mean
ITSav	Males	128	3.7630	1.05505	0.09325
	Females	157	3.6773	1.07842	0.08607

Source: Authors' own analysis

As can be seen in the previous table, the mean value is slightly higher for males than for females. To test this difference, we applied an independent samples t-test (Table 13).

Table 13: Independent Samples Test

	Levene's Test for Equality of Variances		t-test for Equality of Means		
	F	Sig.	t	Sig. (2-tailed)	Mean Difference
Equal variances assumed	0.021	0.884	0.674	0.501	0.08574
Equal variances not assumed			0.676	0.500	0.08574

Source: Authors' own analysis

As the p-value was higher than 0.05, it can be concluded that the difference in the average level of students' perceptions towards ITS between the male and female gender was non-significant.

Moreover, students' perceptions regarding ITS were examined in the context of AI anxiety. Their relation was investigated through correlation analysis.

Table 14: Correlation

		ITSav	AIAav
ITSav	Pearson Correlation	1	-0.059
	Sig. (2-tailed)		0.318
	N	285	285
AIAav	Pearson Correlation	-0.059	1
	Sig. (2-tailed)	0.318	
	N	285	285

Source: Authors' own analysis

Although the coefficient of correlation was negative, pointing out that the decrease in the average value of AI anxiety was associated with the increase in the average value of students' perceptions of ITS, this relation was not significant, bearing in mind the p-value lower than 0.05.

5. Conclusion

The rapid development of technology brings new ways of managing and operationalizing activities in different sectors. Thus, numerous changes and improvements have been implemented in the field of education. Among them are the intelligent tutoring systems, which can be based on artificial intelligence technology.

The use of ITS systems can have many benefits for teachers and students, especially concerning online learning. In addition, their application could help resolve some issues related to the process of distance education.

In certain studies, attention was paid to students' perceptions regarding intelligent tutoring systems. They were conducted among senior secondary school students (Adelana and Akinyemi, 2021) as well as among university students (Karaci et al., 2018). Regarding the results of this research, the levels of perceptions were relatively high, indicating that respondents perceived ITS systems useful for many things, including the provision of real-time diagnosis of learning state, the assignment of learning tasks following their learning state, and the offer of timely feedback related to their learning. This may reflect their readiness to use the ITS systems. Hence, the student's intention to use ITS was frequently reported in the study of Karaci et al. (2018). Moreover, no significant difference from the aspect of gender, nor a significant relationship with AI anxiety were found.

In future studies, analyzed perceptions could be investigated regarding other variables such as AI literacy, or the intention to use AI technology in education. Moreover, differences in the type of faculty students attend may also be included in the research.

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