ADAPTIVE LEARNING THROUGH ARTIFICIAL INTELLIGENCE IN ENTREPRENEURSHIP EDUCATION

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Abstract: The principal objective of this research is to analyze the determining factors of the satisfaction of the use of AI in education among the students at a technical university. The investigated factors include Student-Centric Factors (SCF), Technological factors (TF), Instructional Design Factors (IDF), Environmental factors (EF), and Sustainability factors (SF). This study uses an online questionnaire. The data were collected through a rigorous and comprehensive questionnaire in accordance with the results obtained from VosViewer (research sample consisting of 240 students). The results show that the Student-Centric Factors (SCF), Technological factors (TF), Instructional Design Factors (IDF), Environmental factors (EF), and Sustainability factors (SF) factors contribute to the increase of student satisfaction. Research limitations refer to forming the sample from the students at a single technical university. This research can be extended to other universities, being pilot research now.
Key words: Lifelong learning, competencies management, future learning environments, education system, training system, machine learning, regression.

1. INTRODUCTION

Learning is an important component for the development of individuals. This starts early and does not end with the graduation of a master's degree. It continues throughout life and thus we speak of lifelong learning. Lifelong learning is a voluntary activity that involves individual motivation [1, 2].

Adaptive learning describes the ability of a system to adapt to learning differences between students by meeting the needs and experiences of each student. Practically, it is a continuous adaptation to the students' learning trajectory. This capacity of the system is important in the current dynamics of the university environment and technology [3]. The integration of artificial intelligence (AI) in adaptive learning revolutionizes education and brings additional motivation for the students involved. data analytics and machine learning algorithms are drivers of AI that contribute to good training of students.

The [4] research shows that adaptive learning generated positive results for the target group

and led to an increase in the efficiency of the activities carried out. Research [5–8] show that AI is increasingly used in lifelong learning. Research [1,2] emphasize that learning algorithms are efficient and develop new directions for improving the capacity of the learning system. The [5,8,9] research shows that adaptive learning is important in the fields of entrepreneurship and programming. All these studies reinforce our need to use AI in learning [10–13]. AI offers several opportunities to improve learning outcomes, from writing to translation, process tracking and chatbot or virtual assistants. Adapting the learning process to the needs of the individual is an important activity for the digital transformation in the field of education.

The structure of the paper is highlighted through the two parts of the research. The first part presents semi-quantitative research using VosViewer to highlight gaps in the specialized literature and identify keywords for adaptive learning and AI in the entrepreneurial field. The second part includes the quantitative evaluation of the questionnaire applied to students from a

technical university. The results of the research and related documents are presented.

This research has to offer the answers to the following questions:

- What are the needs for entrepreneurial education for students from technical universities?
- How is adaptive learning valued by technical university students?

2. ARTIFICIAL INTELLIGENCE

AI has the potential to address and solve the biggest challenges in education [2]. The educational process is becoming dynamic, and the generations of students are different. AI in education generates a series of benefits. These benefits [3,5] [14]are presented in Table 1.

Table 1

The potential benefits of AI in education.

| Benefits	Description
Personalized learning	AI offers tools for personalizing learning according to objectives and stakeholders.
Personalized education	AI offers tools for personalizing the education process according to objectives and expected results.
Feedback automation	The student receives automatic feedback after each test or activity.
Accessibility	It offers a high degree of accessibility using digital transformation in teaching-learning processes.
Process efficiency	AI offers educators the opportunity to focus on education and less on the bureaucracy of the process leading to an increase in student satisfaction.
Continuous assessment	The student receives the test results in real time and advances according to his learning pace.
Improving results	Because the learning process adapts to the student's level, it will provide an improvement in results.
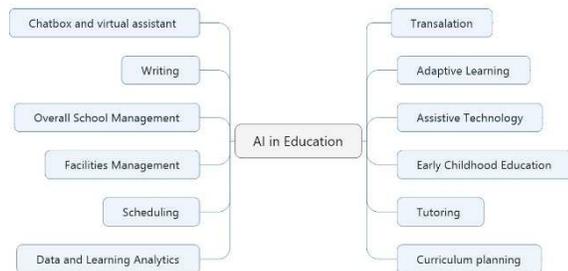
Fig. 1. Example of AI in education.

Among the disadvantages of AI in education are memory weakening, dependence on technology, depersonalization, reducing the level of communication and reducing the impact on complementary work teams. Depending on the discipline, individual, educator and organization, the advantages and disadvantages can be different and have a different impact.

The use of AI in education has become a concern for many organizations. The examples of AI in education are numerous [4, 5, 7, 15–17]. These are used according to the needs of the educator-student-organization and are developed in relation to technological advance. There are several tools that can be used and that generate benefits for the organization and the students. A few tools are shown in Figure 1.

3. MAPPING ENTREPRENEURSHIP EDUCATION WITH ARTIFICIAL INTELLIGENCE

VosViewer was used for mapping and its details are presented below. The research used Web of Science as a database because it is an important database for research in Romania and the European Union. To identify the important articles, the following search words were used: AI, entrepreneurial education, machine learning, deep learning. In this version, 732 articles were identified.

The details of this research are:

- These articles have 1614 unique keywords.
- The criterion was imposed that a keyword should appear in at least 5 publications.
- Thus, 88 keywords were selected. For the 88 keywords, the number of links with other keywords was calculated, and the most frequent ones are highlighted
- The type of analysis used is co-occurrence, and the appearance of a keyword must be at least five times in the selected articles.

Among the most important keywords were AI, entrepreneurship, innovation, technology, performance, big data, management machine learning and impact. The complete list is shown in Fig. 2.

Selected	Keyword	Occurrences ∨	Total link strength
☑	artificial intelligence	121	434
☑	entrepreneurship	121	467
☑	innovation	70	343
☑	artificial-intelligence	33	170
☑	technology	33	164
☑	performance	32	162
☑	big data	31	139
☑	management	31	180
☑	machine learning	28	111
☑	impact	22	110
☑	education	21	83
☑	business	20	83
☑	knowledge	17	84
☑	future	16	82
☑	digitalization	15	100
☑	digital transformation	15	73
☑	framework	14	74
☑	perspective	14	86
☑	transformation	14	79

Fig. 2. The keywords with the most occurrences.

Selected	Keyword	Occurrences ∨	Total link strength
☑	social entrepreneurship	6	22
☑	work	6	28
☑	blockchain	5	30
☑	communication	5	22
☑	covid-19	5	14
☑	creation	5	38
☑	determinants	5	33
☑	effectuation	5	30
☑	entrepreneurs	5	22
☑	exploration	5	25
☑	fintech	5	25
☑	firm	5	25
☑	firm performance	5	19
☑	models	5	27
☑	self-efficacy	5	17
☑	smes	5	27
☑	social media	5	17
☑	university	5	17
☑	user acceptance	5	29
☑	value creation	5	25

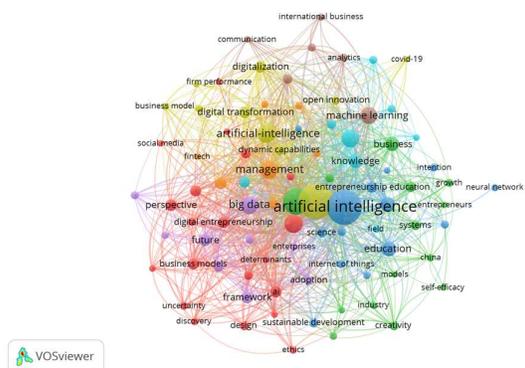**Fig. 3.** The keywords with the fewest occurrences.

Fig. 4. The strong links between "artificial intelligence" and the selected words.

Fig. 3 shows the keywords and the number of their occurrences for the least frequent keywords. The number of links within the network of selected articles is also presented.

Fig. 4 shows the results obtained for the keyword "artificial intelligence" which shows the most connections with the selected database. A strong connection can be observed with "big data". It presents links with research that includes the keywords sustainability, framework, science, entrepreneurship, education, management, neural network,

intention, business, open innovation, machine learning, digital transformation and others.

Fig. 5 intensifies the links between "artificial intelligence" and "technology" and highlights the strong links with digitization, open innovation, machine learning, management, dynamic capabilities, knowledge, business model, growth, future, uncertainty, creation and design.

Fig. 6 shows the strong links between "technology" and the keywords that are related to "artificial intelligence". Thus, links were obtained with management, machine learning, innovation, digital transformation, systems, adoption, perspective and design.
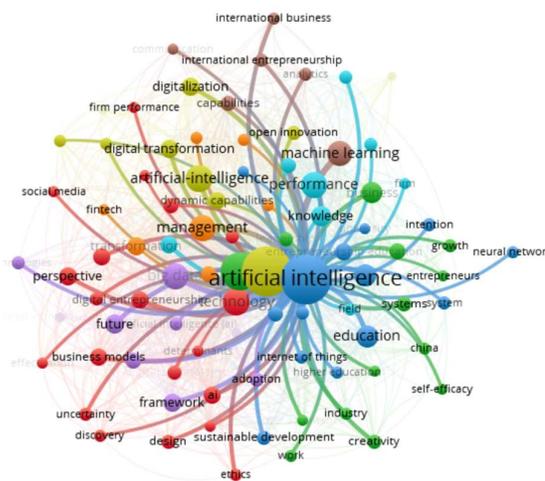

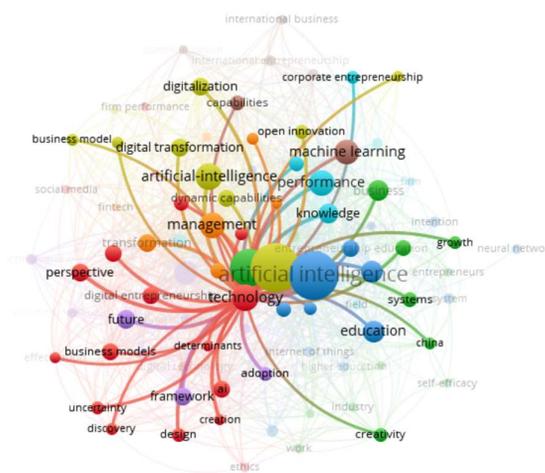**Fig. 5.** The links between "artificial intelligence" and "technology".

Fig. 6. The strong links between "technology" and the keywords that are related to "artificial intelligence".

Fig. 7 shows the strong links between "digital entrepreneurship" and the keywords that are related to "artificial intelligence". Thus, links were obtained with future, management, knowledge, performance, social media, models, internet of things, user acceptance and framework.

Fig. 8 shows the connection between "artificial intelligence" and "big data". In relation to the 2 words, the following key words machine learning, education, creation, management, growth, opportunities, technologies, future, business models, internet of things, science and model are highlighted.

Fig. 9 shows the situation of the year of publication of articles that include keywords with strong links (more than five occurrences).

Fig. 7. The strong links between "digital entrepreneurship" and the keywords that are related to "artificial intelligence".

Fig. 8. The connection between "artificial intelligence" and "big data".

Fig. 9. The keywords with the fewest occurrences.

The year 2023 brings links with models, adoption, management, determined, sustainable development, education and industry. The complete links can be viewed in the figure using the legend related to the years of publication.

3. METHODOLOGY

The main objective of this research is to analyze the determining factors of the satisfaction of the use of AI in education among the students from a technical university. This study uses an online questionnaire. The data were collected through a rigorous and comprehensive questionnaire in accordance with the results obtained from VosViewer. The sample consisted of 240 students. To assess the data and derive conclusions, confirmatory factor analysis was used.

The sample was calculated with Raosoft with a margin of error of 5%, confidence level 95%, a response distribution rate of 90% and a student size of over 10,000.

The questionnaire was applied using Google Form and was structured in 2 parts. The first part was aimed at identifying the level of entrepreneurial education and students' interests, while the second part was aimed at identifying the level of satisfaction related to the adaptive learning in entrepreneurship carried out at the university.

Fig. 10. The conceptual model of AI in entrepreneurial education.

For the second part, the following factors were considered:

- Student-Centric Factors (learning style, motivation, learning goals) comprise a series of sub-factors that define the student.
- Technological factors (platform, content quality, tools, accessibility, security and privacy) refer to the digital transformation related to the teaching-learning process.
- Instructional Design Factors (assessment method, content delivery, learning objectives) refers to the educator and the ability to adapt to the student's profile.
- Environmental factors (faculty training, economic factors, institutional factors) that include microenvironmental and macroenvironmental factors.
- Sustainability factors (collaboration, network, relevance, continuous improvement) include the ability to develop over a long period of time.

The conceptual model of AI in entrepreneurial education is shown in Fig. 10. In this model five categories of factors are included.

4. RESULTS AND DISCUSSION

This chapter includes the results obtained from the quantitative analysis of the applied questionnaire. The results are presented in the two categories found in the design of the questionnaire.

Fig. 11 includes a series of courses that would contribute to the entrepreneurial education of students. Each student selected a maximum of 5 courses, and the most appreciated courses were "Personal development for entrepreneurs" and "Generative AI/Most recent developments in AI".
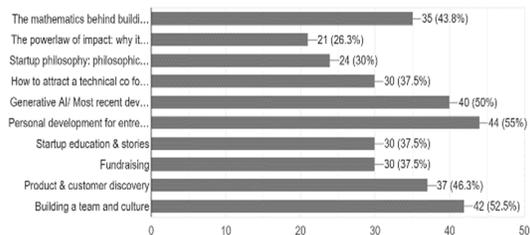

Fig. 11. The keywords with the fewest occurrences.

Figure 12 presents the students' perception of the importance of entrepreneurial education. 180 students appreciated above average importance. This result is also influenced by the social factors and the objectives of the students from the technical university.

Fig. 13 shows the appreciation of the personal level of entrepreneurial skills and it is in direct proportionality with Figure 12. The training level of the students is below average. An important factor could be the reduced number of entrepreneurial subjects in the educational plans.

Cronbach's alpha is calculated to check the reality of the items. A value of 0.6 indicates a generally accepted threshold. The study items indicate an average value of 0.775 which confirms the reliability of the scales used.

To test the validity of the sample, the Kaiser-Meyer-Olkin (KMO) and Bartlett's tests were used. The test is statistically significant because the P-value is less than 0.05, and the KMO value is 0.94, which confirms the appropriateness of the sample and the scales used in the data analysis, Fig. 14.
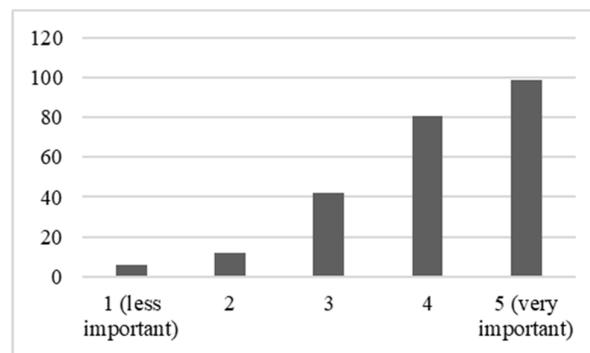

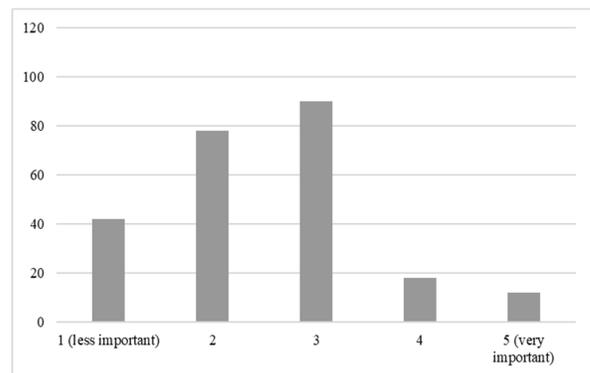**Fig. 12.** The importance of entrepreneurial courses for students.

Fig. 13. Appreciation of the personal level of entrepreneurial skills.

Reliability Test.

No	Variable	Questions					Cronbach's Alpha
1	Student-Centric Factors (SCF)	11	31	51	71	91	0.817
2	Technological factors (TF)	13	33	53	73	93	0.804
3	Instructional Design Factors (IDF)	14	34	54	74	94	0.853
4	Environmental factors (EF)	16	36	56	76	96	0.611
5	Sustainability factors (SF)	18	38	58	78	98	0.792
Average							**0.775**

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.918
Bartlett's Test of Sphericity	Approx. Chi-Square	2477.488
	df	301
	Sig.	.000

Fig. 14. Kaiser-Meyer-Olkin Measure and P-value.

From the perspective of the factor loading of the data, values higher than 0.6 were obtained, which confirms the importance of the components. In the following table, Table 3, measurements including coefficients and p-values are presented.

All the measurements included in the model contribute significantly to the satisfaction of students in technical university. It can be observed that the coefficient of SCF has the highest value and can be interpreted as having the greatest influence on the satisfaction of entrepreneurship education.

The smallest compensation shows a lower importance.

The results of the importance of the coefficient.

Structural equation model	Number of obs	=	240
Estimation method = ml			
Log likelihood = -1398.6751			

	OIM			
Standardized	Coef.	Std. Err.	z	P>|z|
Measurement				
Student-Centric Factors (SCF) <-				
AI in education (adaptive learning)	.8480024	.024321	33.13	0.000
_cons	3.753787	.223456	16.96	0.000
Technological factors (TF) <-				
AI in education	.6889056	.041298	15.63	0.000
_cons	2.858946	.1678902	16.43	0.000
IDF <-				
AI in education	.7186083	.04201	25.40	0.000
_cons	3.653595	.2243697	17.36	0.000
EF <-				
AI in education	.6123455	.0512435	11.21	0.000
_cons	2.930682	.1983919	15.55	0.000
SF <-				
AI in education	.7560467	.0435961	24.57	0.000
_cons	3.649795	.2134103	16.91	0.000
var(e.SCF)	.3248349	.0541892		
var(e.TF)	.5034561	.0514879		
var(e.IDF)	.4567168	.0499763		
var(e.EF)	.6467837	.0628917		
var(e.SF)	.4569825	.0590122		
LR test of model vs. saturated: chi2(11)=13.98, Prob > chi2 =0.2104				

5. CONCLUSION

This is a pilot study that will be extended to other technical or comprehensive universities. The present research shows that there is a strong link between artificial intelligence and entrepreneurial education based on the results obtained in VosViewer. The same conclusion is supported by the results of the survey conducted at the technical university.

The level of preparation in the entrepreneurial field of the students is below average. There is an increased interest of students in entrepreneurship courses. The courses that are of interest to students are in the field of AI in education.

The research proves that all five categories of factors, Student-Centric Factors (SCF), Technological factors (TF), Instructional Design Factors (IDF), Environmental factors (EF), and Sustainability factors (SF), influence adaptive learning through artificial intelligence in the field of entrepreneurship. forming the sample from the students at a single technical university.

This research can be extended to other universities, being pilot research now. Entrepreneurial education is important for students from technical and comprehensive universities, as shown in specialized literature. Furthermore, the development of basic skills in entrepreneurship becomes an important condition in the dynamics of the current environment [18, 19].

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Învățarea adaptivă folosind inteligentă artificială în educația antreprenorială

Progresul tehnologic contribuie la dezvoltarea unor noi sisteme de învățare caracterizate prin adaptare permanentă și inteligență artificială. Studenții universităților tehnice identifică o serie de nevoi de formare în domeniul competențelor antreprenoriale. Obiectivul principal al acestei cercetări este de a analiza factorii determinanți ai satisfacției utilizării inteligenței artificiale în educația antreprenorială în rândul studenților unei universități tehnice. Satisfacția este un factor determinant care influențează dezvoltarea profesională și eficiența procesului de predare-învățare. Factorii investigați cuprind factorii-centrați pe studenți (SCF), factorii tehnologici (TF), factorii de proiectare instrucțională (IDF), factorii de mediu (EF) și factorii de sustenabilitate (SF). Acest studiu utilizează chestionarul online. Datele au fost colectate printr-un chestionar riguros și cuprinzător în concordanță cu rezultatele obținute din VosViewer. Eșantionul a fost format din 240 de studenți. Pentru a evalua datele și a sistematiza concluziile se va folosi o analiză factorială de confirmare. Rezultatele arată că factorii centrați pe studenți (SCF), factorii tehnologici (TF), factorii de proiectare instrucțională (IDF), factorii de mediu (EF) și factorii de sustenabilitate (SF) contribuie la creșterea satisfacției studenților în domeniul educației antreprenoriale. Limitările cercetării se referă la formarea eșantionului din studenții unei singure universități tehnice. Această cercetare poate fi extinsă și la alte universități, fiind în acest moment o cercetare pilot.

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