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INTELLIGENT TUTORING SYSTEMS IN EDUCATION: A SYSTEMATIC REVIEW OF USAGE, TOOLS, EFFECTS AND EVALUATION

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ABSTRACT

Computer learning has grown more integrated with artificial intelligence approaches as technology has advanced, allowing for the development of more customized educational systems. Intelligent Tutoring Systems (ITS) are the name given to these systems (ITSs). This article concentrated on the many applications of ITSs created in various educational disciplines. The original studies were gathered from the Scopus, Web of Science, and Google Scholar databases between 2016 and 2022. Finally, depending on inclusion criteria, 36 publications were included in the research. Computer Sciences (36.1%) were the most common educational fields in ITSs. And Social Science, Medicine, Engineering, and Mathematics, with 27.7%, 13.8%, 8.3%, and 5.5% frequency, respectively were the most often used artificial intelligence approaches in ITSs. ITSs may use these strategies to provide adaptive guidance and training, assess learners, establish and update the learner's model, and categorize or cluster learners. The PRISMA technique is employed in this systematic literature review to select the related research and to discuss the many usage of ITSs, the tools used, the effects, and evaluation methods. Finally, we discuss the significance of ITSs in the educational process and their influence on student accomplishment, since they were utilized for school and university students and had a substantial impact on their level growth.

Keywords: *Intelligent Tutoring System, Intelligent Tutor System, Intelligent Tutoring Application, Intelligent Tutor Application, ITS, ITSB, Education*

1. INTRODUCTION

The educational environment has changed dramatically during the last decade. The emphasis has changed away from conventional teaching techniques and toward incorporating technology into today's curriculum. Much focus is placed on developing 21st-century abilities via the use of new and creative technologies. Student participation is an essential component of learning [28].

According to [2], traditional education is incapable of accommodating varied learning styles and degrees of preparation. This technique detects a significant number of students who are dealing with a single instructor who is unable to address each student's needs. As a consequence, some students may be unsatisfied and unable to achieve their academic objectives.

Individualization is lost in conventional education in large groups of students because it is impossible for a teacher to construct a personalized study plan that suits the needs of each individual in the group. And there are fewer teaching styles in traditional schooling. Pictures, movies, and discussion boards are not always accessible. This trait may impede learning and interfere with an effective study [21].

In recent decades, the application of artificial intelligence (AI) technology, particularly machine learning, has developed in educational institutions and people have become increasingly reliant on applications and software in a variety of fields, including learning, as information technology has advanced and computers have been more widely used [21].

According to [10], Intelligent learning systems (ITS) can be defined as computer-based educational systems that have independent databases, or knowledge bases for educational content in addition to teaching strategies and try to use conclusions about the learner's ability to understand topics and identify his weaknesses and strengths so that they can adapt the learning process dynamically.

ITS is made up of four essential components: an expert model, a student model, pedagogic knowledge, and an interface. The expert model offers a model of expert performance against which the learner is evaluated. ITS dynamically models the learner over various issues or scenarios. The system's pedagogical judgments concerning tutorial technique, case selection, and curriculum sequencing may be influenced by the student state assessment [35].

Authors in [5] demonstrate that intelligent tutoring systems have been used in many educational fields such as information technology, engineering, languages, mathematics, programming, and medicine, and many tools are available to develop intelligent tutoring systems for non-programmers with the possibility of programming software systems such as web-based and mobile-based systems.

According to [27], students who utilized intelligent tutoring systems performed better academically than students who did not use the system and instead relied on conventional education.

After reviewing the available review papers, we discovered that certain questions remain unanswered. As a result, the goal of this research was to collect complete information regarding the ITSs established across all educational fields, including their usage, tools employed, effects, and evaluation methodologies. This study was based on the researches between 2016 and 2022 using Scopus, Web of Science and Google Scholar databases. And the methodology used in this study is Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA).

2. METHODOLOGY

We implemented this Systematic Literature Review (SLR) to better understand the concept, usage, effects and evaluation of an intelligent teaching system in addition to tools used to implement the ITS. This systematic review was carried out in accordance with Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA). Figure 2 depicts the PRISMA data collecting and processing procedure.

According to [1][2], PRISMA is an evidence-based minimal set of elements for reporting in systematic reviews and meta-analyses. PRISMA primarily focuses on the reporting of reviews evaluating the impact of treatments.

We conducted this Systematic Literature Review by a group of steps: the first step is identifying the research questions, the second step is the construction of the research strategy such as choosing the academic research databases such as Scopus, Web of Science and Google Scholar, the third step is construction the inclusion and exclusion criteria using PICO questions and SLR tools such as populations, study type and time frame(2016-2022), the fourth step is a selection process based on (title/abstract) of researches, the fifth step is data extraction based on some criteria such as research title, authors, ITS tool, education field and etc., the last step is results and discussion. Figure 1 shows the steps of this Systematic Literature Review.

Figure 1: The steps of Systematic Literature Review

2.1 Research Questions

We have prepared the following research questions to keep the research on track. This systematic review answers the following research questions:

RQ 1: For which educational fields ITSs have been designed?

RQ 2: Which tools have been applied in the development of ITSs?

RQ 3: What are the main purposes of using ITSs?

RQ 4: What types of user-interface have been used for development of ITSs?

RQ 5: What are the effects of using ITSs in education?

RQ 6: Which methods have been employed for the evaluation of ITSs?

2.2 Search Strategy

The search was done out in the following academic research databases between (2016 and 2022), Web of Science, Scopus, and Google Scholar. The following keywords relating to intelligent tutoring systems and education were used to form the search query:

(Intelligent OR adaptive) AND (tutoring OR tutor OR teaching OR learning) AND (system OR software OR application) AND (education OR "higher education" OR university)

To guarantee that no relevant papers were missed (false negatives), we repeated the search with fresh synonymous keywords until the search returned no new documents that fulfilled the inclusion criterion.

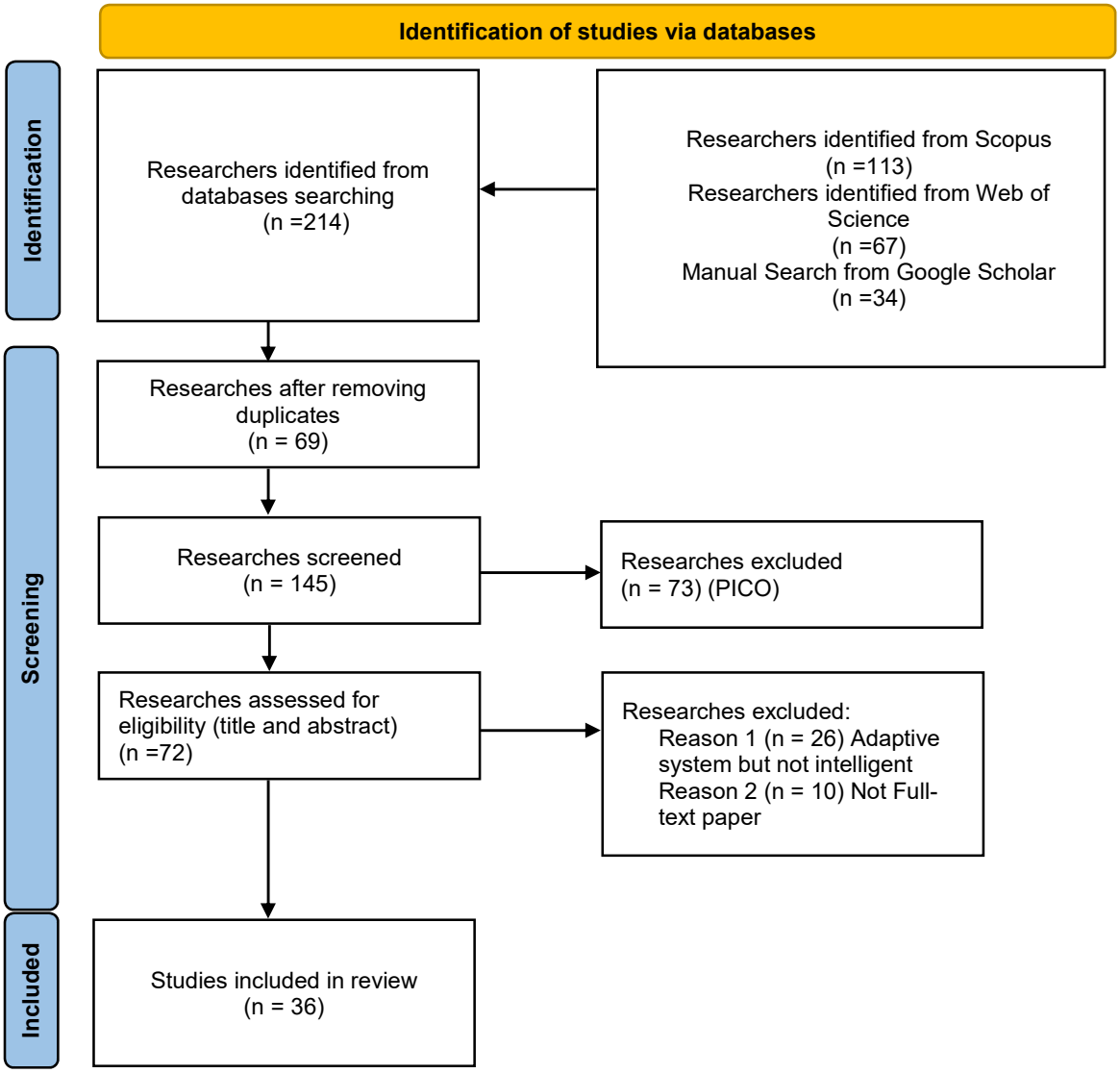

Figure 2 PRISMA Data Collecting and Processing Procedure.

2.3 Inclusion and Exclusion Criteria

We carried out the inclusion and exclusion criteria using the PICO question and STL tool. The PICO criteria were utilized to create the search string: population (P), intervention (I), comparison (C), and outcome (O), and the STL tool was used to specify (S) Study Type, (T) Time Frame, and (L) Language [17].

This search found 214 articles (113 from Scopus, 67 from Web of Science, and 34 from a manual search in Google Scholar), which we imported into Endnote, a reference management system.

We started the screening process by looking for duplicates, which resulted in the elimination of 69 articles. The remaining articles were then examined to see whether they matched the following inclusion criteria:

- Education-related.
- Published in peer-reviewed journals.
- Full-text papers.
- Time range between 2016 and 2022.
- Published in English.

To be included in the review, a research has to match all of our criteria. We restricted the evaluation to 36 papers after removing duplicates and applying these selection criteria to the remaining 72 publications (see Figure 2).

The most prevalent grounds for studies being excluded were because they focused largely on the description of the design or evolution of a system and adaptive system but not intelligent systems. In addition to not having full-text papers, as the number of researches that was excluded for these reasons was 36 research.

2.4 SELECTION PROCESS (Screening)

The articles were first evaluated by two different reviewers based on the research and PICO questions based on the title and abstract using an Excel sheet (see Figure 3 for Title and Abstract Screening).

The reviewers examined the titles and abstracts of all the articles and classified them into three categories during this step. The first group consisted of articles that clearly met the inclusion criteria and were awarded the number 1. The following category comprised of publications awarded the number 3 since the reviewers were doubtful about their inclusion criteria. Finally, the final group received the number 2 since it lacked inclusion requirements. The papers were then eliminated if they received the 2.

The reviewers debated and agreed on the articles that did not earn the same number. All papers with the same number (1 or 3) were considered for the next step. Finally, for the second stage screening, the full-text of the included publications was retrieved and reviewed by two reviewers.

Author	Year	Title	Abstract	URL	Is Related to Education	Source	Decision			Cause of Exclusion
							1	2	3	
							Included	Excluded	Unsure	
H. E. Samra, A. S. Li, B. Soh and M. A. Alzain	2017	A Conceptual Model for an Intelligent Simulation-Based Learning Management System Using a Data Mining Agent in Clinical Skills Education	Clinical skills education is an essential component of the teaching plan in medical science courses, such as nursing education. Simulation-based learning is an effective teaching method in any practical or vocational-based training. The development of simulation-based teaching has been impacted by the integration of emerging technologies, such as Intelligent Tutoring Systems (ITSs), which results in a more interactive and adaptive environment. Recently, educational data mining (EDM) has played an important role in the development of ITSs by providing different methods and techniques to predict a student's performance. Research carried out to deliver intelligent simulation-based systems for clinical skills teaching has applied several artificial intelligence techniques, however there is a lack	https://ieeexplore.ieee.org/document/7880476	yes	Scopus				

Figure 3 Title and Abstract Screening

2.5 DATA EXTRACTION

The following factors were retrieved at this step-in order to answer the study objectives. These factors included the system's name, the research population, the ITS tool, the methods of evaluation, the effects, and the area of education (see Table1, Table2 and Table3).

Table 1 Data Extraction Form

Ref. No.	Author (Year)	Title	Article Type	Journal Name	Source
[32]	Lu, Y., Pian, Y., Chen, P., Meng, Q., & Cao, Y. (2021)	RadarMath: An Intelligent Tutoring System for Math Education	Conference Paper	35th AAAI Conference on Artificial Intelligence	Scopus
[39]	Qiu, D. (2018)	Development and Implementation of Learning System of an Intelligent Learning System for Ideological and Political Education in Colleges under Mobile Platform	Conference Paper	Proceedings - 2018 International Conference on Virtual Reality and Intelligent Systems	Scopus
[7]	Al Rekhawi, H. A., & Abu Naser, S. S. (2018)	An intelligent tutoring system for learning Android applications UI development	Journal	International Journal of Engineering Information Systems	Google Scholar
[31]	Li, X. (2018)	Design and implementation of an intelligent system for ideological and political education learning under the mooc environment	Conference Paper	Proceedings - 2018 International Conference on Virtual Reality and Intelligent Systems	Scopus
[25]	Hoppe, L. V., Gembarski, P. C., & Lachmayer, R. (2021)	Intelligent Tutoring System as A Tool of Formative Assessment in Design Education	Conference Paper	Proceedings of the 23rd International Conference on Engineering and Product Design Education	Scopus
[13]	Alnajar, A. E. A., & Hanjory, M. (2017)	ITS for teaching DES information security Algorithm	Journal	International Journal of Advanced Research Development	Google Scholar
[45]	Yang, Y. (2021)	Design and Implementation of Intelligent Learning System Based on Big Data and Artificial Intelligence	Journal	Frontiers in Psychology	Scopus
[26]	Kadhim, M. K., & Hassan, A. K. (2020)	Towards Intelligent E-Learning Systems: A Hybrid Model for Predicating the Learning Continuity in Iraqi Higher Education	Journal	Webology	Scopus
[18]	Bernard, E. C., Bernadine, O. I., Ngozi, E. B., Okechukwu, O. C., & Amara, O. J. P. (2020)	Evaluation of software and architectural design requirement specifications for developing an intelligent tutor system for learning computer networking in universities in Nigeria	Journal	Universal Journal of Educational Research	Scopus
[4]	AbuEl-Reesh, J. Y., & Abu-Naser, S. S. (2018)	An Intelligent Tutoring System for Learning Classical Cryptography Algorithms (CCAITS)	Journal	International Journal of Academic Applied Research	Google Scholar
[43]	Wei, M. (2022)	The Design of Intelligent Tutoring Systems Using College Students' Innovation and Entrepreneurship Education under the Background of Online Teaching	Journal	Wireless Communications and Mobile Computing	Scopus
[11]	Almurshidi, S. H. (2017)	Stomach disease ITS	Journal	International Journal of Advanced Research Development	Google Scholar
[19]	Bernard, J., Wainman, B., Walker, O., Pitt, C., Bayer, I., Mitchell,	Grading OSPE Questions with Decision Learning Trees: A First Step towards an Intelligent Tutoring System for Anatomical Education	Conference Paper	CEUR Workshop Proceedings	Scopus

	J., . . . Sonnadara, R. (2021)				
[8]	Al-Bastami, B. G., & Abu-Naser, S. S. (2017)	Design and Development of an Intelligent Tutoring System for C# Language	Journal	European Academic Research	Google Scholar
[15]	Aparicio, F., Morales-Botello, M. L., Rubio, M., Hernando, A., Muñoz, R., López-Fernández, H., . . . Buenaga, M. D. (2018)	Perceptions of the use of intelligent information access systems in university level active learning activities among teachers of biomedical subjects	Journal	International Journal of Medical Informatics	Scopus
[42]	Tafazoli, D., María, Parra, E. G., & Abril, C. A. H. (2019)	Intelligent language tutoring system: Integrating intelligent computer-assisted language learning into language education	Journal	International Journal of Information and Communication Technology Education	Scopus
[34]	Mohamed, H., & Bashhar, B. (2017)	ITS for Teaching The 7 Characteristics for Living Things	Journal	International Journal of Advanced Research Development	Google Scholar
[38]	Putra, A. B. N. R., Insani, N., Winarno, A., Puspitasari, P., Kiong, T. T., Habibi, M. A., . . . Subandi, M. S. (2021)	The innovation of intelligent system e-consultant learning to improve student mindset of vocational education in the disruptive Era 4.0	Journal	Journal of Physics: Conference Series	Scopus
[40]	Samra, H. E., Li, A. S., Soh, B., & Alzain, M. A. (2017)	A Conceptual Model for an Intelligent Simulation-Based Learning Management System Using a Data Mining Agent in Clinical Skills Education	Conference Paper	Proceedings - 4th International Conference on Enterprise Systems: Advances in Enterprise Systems, ES 2016	Scopus
[30]	Laaziri, M., Benmoussa, K., Khoulji, S., & Larbi, K. M. (2018)	Outlining an Intelligent Tutoring System for a University Cooperation Information System	Journal	Engineering Technology & Applied Science Research	Web of Science
[16]	Bakeer, H. M. S., & Abu-Naser, S. S. (2019)	An intelligent tutoring system for learning TOEFL	Journal	International Journal of Academic Pedagogical Research	Google Scholar
[46]	Zhang, X., & Cao, Z. (2021)	A Framework of an Intelligent Education System for Higher Education Based on Deep Learning	Journal	International Journal of Emerging Technologies in Learning	Scopus
[22]	Fang, Y., Lippert, A., Cai, Z., Chen, S., Frijters, J. C., Greenberg, D., & Graesser, A. C. (2022)	Patterns of Adults with Low Literacy Skills Interacting with an Intelligent Tutoring System	Journal	International Journal of Artificial Intelligence in Education	Scopus
[36]	Nakhal, M., & Bashhar, B. (2017)	Adaptive ITS for Learning Computer Theory	Journal	European Academic Research	Google Scholar
[20]	Cao, F., Xiang, M., Chen, K., & Lei, M. (2022)	Intelligent Physical Education Teaching Tracking System Based on Multimedia Data Analysis and Artificial Intelligence	Journal	Mobile Information Systems	Scopus

[37]	Ognjenovic, P. (2017)	Experimental verification of the effectiveness of learning and teaching using intelligent tutoring system in secondary school education	Conference Paper	2017 25th International Conference on Software, Telecommunications and Computer Networks, SoftCOM 2017	Scopus
[23]	Hasanein, H. A. A., & Abu-Naser, S. S. (2018)	Developing education in Israa University using intelligent tutoring system	Journal	International Journal of Academic Pedagogical Research	Google Scholar
[29]	Kochmar, E., Vu, D. D., Belfer, R., Gupta, V., Serban, I. V., & Pineau, J. (2022)	Automated Data-Driven Generation of Personalized Pedagogical Interventions in Intelligent Tutoring Systems	Journal	International Journal of Artificial Intelligence in Education	Scopus
[9]	Aljameel, S. S., O'Shea, J. D., Crockett, K. A., Latham, A., & Kaleem, M. (2017)	Development of an Arabic Conversational Intelligent Tutoring System for Education of children with ASD	Conference Paper	2017 IEEE International Conference on Computational Intelligence and Virtual Environments for Measurement Systems and Applications	Scopus
[35]	Mosa, M. J., Albatish, I., & Abu-Naser, S. S. (2018)	ASP.Net-Tutor: Intelligent Tutoring System for Leaning ASP.Net	Journal	International Journal of Academic Pedagogical Research	Google Scholar
[44]	Wolfe, C. R., Reyna, V. F., Widmer, C. L., Cedillos-Whynott, E. M., Brust-Renck, P. G., Weil, A. M., & Hu, X. (2016)	Understanding genetic breast cancer risk: Processing loci of the BRCA Gist Intelligent Tutoring System	Journal	Learning and Individual Differences	Scopus
[12]	Almurshidi, S. H., & Naser, S. S. A. (2017)	Design and Development of Diabetes Intelligent Tutoring System	Journal	European Academic Research	Google Scholar
[3]	AbuEloun, Nour N. & Abu Naser, Samy S. (2017)	Mathematics Intelligent Tutoring System	Journal	International Journal of Advanced Scientific Research	Google Scholar
[24]	Hiles, M., & Agha, M. (2017)	Knowledge-based ITS for Teaching Mongo Database	Journal	European Academic Research	Google Scholar
[33]	Marouf, A., Yousef, M. K. A., Mukhaimer, M. N., & Abu-Naser, S. S. (2018)	An Intelligent tutoring System for Learning Introduction to Computer Science	Journal	International Journal of Academic Multidisciplinary Research	Google Scholar
[14]	Alsobhi, A. Y., & Alyoubi, K. H. (2019)	Adaptation algorithms for selecting personalised learning experience based on learning style and dyslexia type	Journal	Data Technologies and Applications	Scopus

Table 2 ITS Tools Used and Education Fields

No.	Author (Year)	ITS Name	ITS Tool/ Technique	Education Field/Subject Area	Course Content/Usage
[32]	Lu, Y., Pian, Y., Chen, P., Meng, Q., & Cao, Y. (2021)	RadarMath	ITS and Deep Learning-Based	Mathematics	Solve and grade the text-answer questions and equations in mathematics
[39]	Qiu, D. (2018)	Mobile Learning Platform	Mobile Application-Android for Front-End and Web Back-End service	Social Sciences	A social practice in which a social group employs certain ideas, concepts, political beliefs, and moral conventions to develop the ideology of students.
[7]	Al Rekhawi, H. A., & Abu Naser, S. S. (2018)	Droid-Tutor	Intelligent Tutoring System Builder - ITSB	Computer Science	Mobile Apps Development for Android
[31]	Li, X. (2018)	MOOC for ideological and political education	MOOC based teaching platform and ASP.NET with SQL Server Database	Social Sciences	Ideological and Political courses
[25]	Hoppe, L. V., Gembarski, P. C., & Lachmayer, R. (2021)	ITS for Design Education	ITS using knowledge-based engineering systems	Engineering and Design	Prepare for a Design course for mechanical engineering students
[13]	Alnajar, A. E. A., & Hanjory, M. (2017)	DES-Tutor	Intelligent Tutoring System Builder - ITSB	Computer Science	DES Algorithm from Information Security Course
[45]	Yang, Y. (2021)	Multimedia Information Management System for Film and Television	Tornado Web technology, NoSQL database, jQuery and Ajax, Big Data and AI	Computer Science	Using the system for different courses such as multimedia
[26]	Kadhim, M. K., & Hassan, A. K. (2020)	E-Learning System	RNN-ADAM algorithm, Pseudo Code for front-end and back-end	Computer Science	Using the system with different six courses such as AI, computer networks, Database, software engineering, operating systems and computer security
[18]	Bernard, E. C., Bernadine, O. I., Ngozi, E. B., Okechukwu, O. C., & Amara, O. J. P. (2020)	ITS for Learning Computer Networking	ITS Web-based HTML, JAVASCRIPT, PHP and CSS	Computer Science	Learning Computer Networking
[4]	AbuEl-Reesh, J. Y., & Abu-Naser, S. S. (2018)	CCAITS-Tutor	Intelligent Tutoring System Builder - ITSB	Computer Science	Classical Cryptography Algorithms
[43]	Wei, M. (2022)	ITS for teaching innovation and entrepreneurship	ITS Prototype	Innovation and entrepreneurship	Innovation and entrepreneurship Course

[11]	Almurshidi, S. H. (2017)	Stomach disease ITS	Intelligent Tutoring System Builder – ITSB and Interface Including 3D Animation with Delphi	Medicine	Diagnosis of Stomach Diseases
[19]	Bernard, J., Wainman, B., Walker, O., Pitt, C., Bayer, I., Mitchell, J., . . . Sonnadara, R. (2021)	ITS Grader for Anatomical Education	ITS Model and OSPE Questions	Medicine	Anatomical Sciences Education
[8]	Al-Bastami, B. G., & Abu-Naser, S. S. (2017)	C#-ITS	Intelligent Tutoring System Builder - ITSB	Computer Science	C# Programming Language
[15]	Aparicio, F., Morales-Botello, M. L., Rubio, M., Hernando, A., Muñoz, R., López-Fernández, H., . . . Buenaga, M. D. (2018)	IIA systems	BioAnnote, CLEiM and MedCMap	Medicine	Biomedical Sciences (BS) and Health Sciences (HS)
[42]	Tafazoli, D., María, Parra, E. G., & Abril, C. A. H. (2019)	ITLS	ITS, NLP and ICALL	Social Sciences	Foreign Language teaching and learning (FLTL)
[34]	Mohamed, H., & Bashhar, B. (2017)	ITS for teaching the 7 characteristics for living things	Intelligent Tutoring System Builder - ITSB	Science	The 7 characteristics for living things
[38]	Putra, A. B. N. R., Insani, N., Winarno, A., Puspitasari, P., Kiong, T. T., Habibi, M. A., . . . Subandi, M. S. (2021)	Intelligent System E-Consultant Learning	Mobile Web-based	Vocational Education	Improve student mindset of vocational education
[40]	Samra, H. E., Li, A. S., Soh, B., & Alzain, M. A. (2017)	ITS for Clinical Skills Education	A conceptual model for an intelligent simulation-based learning system using a data mining	Medicine	Clinical skills education medical science courses
[30]	Laaziri, M., Benmoussa, K., Khoulji, S., & Larbi, K. M. (2018)	ITS with SIMACoop	ITS and Moodle platform	Engineering	Create an intelligent tutoring system. Based on the Moodle platform, this solution will be entirely automated and adaptive to the demands of each student.
[16]	Bakeer, H. M. S., & Abu-Naser, S. S. (2019)	TOEFL-ITS	Intelligent Tutoring System Builder - ITSB	Social Sciences	English language training course to pass the TOEFL exam

[46]	Zhang, X., & Cao, Z. (2021)	Deep-Learning-Based Intelligent Education System for Higher Education	ITS based on Deep Learning	Engineering	Creation of an Intelligent education system, such as learning and exercise data, to complete performance statistics and curve graphing of participants in daily teaching.
[22]	Fang, Y., Lippert, A., Cai, Z., Chen, S., Frijters, J. C., Greenberg, D., & Graesser, A. C. (2022)	AutoTutor for Adults with Limited Reading Literacy	AutoTutor	Social Sciences	Increase reading comprehension in adults with limited reading literacy
[36]	Nakhal, M., & Bashhar, B. (2017)	Adaptive ITS	Intelligent Tutoring System Builder - ITSB	Computer Science	Learning Computer Theory
[20]	Cao, F., Xiang, M., Chen, K., & Lei, M. (2022)	An Intelligent Physical Education Tracking System - IPETS	Web-based and SQL Database with VR and C program	Computer Science	Improve physical and athletic scientific training techniques
[37]	Ognjenovic, P. (2017)	AC-Ware Tutor	Adaptive Courseware Tutor Model	Social Sciences	Business Psychology class (lesson contents of emotion and motivation)
[23]	Hasanein, H. A. A., & Abu-Naser, S. S. (2018)	ITSB for Israa University	Intelligent Tutoring System Builder - ITSB	Computer Science	Computer Skills Course
[29]	Kochmar, E., Vu, D. D., Belfer, R., Gupta, V., Serban, I. V., & Pineau, J. (2022)	Korbit, a large-scale dialogue-based ITS	Web-Based with Natural Language-based Interactions in ITS and Machine Learning	Social Sciences	Personalized Pedagogical Interventions
[9]	Aljameel, S. S., O'Shea, J. D., Crockett, K. A., Latham, A., & Kaleem, M. (2017)	LANA-CITS	CITS and PM with STS similarity algorithm to recognize the user utterance	Social Sciences	Science subjects for autistic students in Arabic, based on conventional school instruction in Saudi Arabia.
[35]	Mosa, M. J., Albatish, I., & Abu-Naser, S. S. (2018)	ASP.Net-Tutor	Intelligent Tutoring System Builder - ITSB	Computer Science	Web Development by ASP.NET Course
[44]	Wolfe, C. R., Reyna, V. F., Widmer, C. L., Cedillos-Whynott, E. M., Brust-Renck, P. G., Weil, A. M., & Hu, X. (2016)	BRCA Gist Intelligent Tutoring System	Fuzzy-Trace Theory, (FTT) and built using AutoTutor	Social Sciences	Understand and make choices regarding breast cancer genetic testing
[12]	Almurshidi, S. H., & Naser, S. S. A. (2017)	ITS for teaching Diabetes	Desktop-Based Intelligent Tutoring System - ITSB	Medicine	Teaching diabetes to students in order to help them overcome the obstacles they confront from clinical medicine books
[3]	AbuEloun, Nour N. & Abu Naser, Samy S. (2017)	Mathematics ITS	Intelligent Tutoring	Mathematics	Teaching the basics of mathematics, such as addition, subtraction, and

			System Builder - ITSB		others, in addition to numbers and their types
[24]	Hiles, M., & Agha, M. (2017)	MDB-ITS	Intelligent Tutoring System Builder - ITSB	Computer Science	Database Course using NoSQL Mongo database
[33]	Marouf, A., Yousef, M. K. A., Mukhaimer, M. N., & Abu-Naser, S. S. (2018)	Computer Science Course-Tutor	Intelligent Tutoring System Builder - ITSB	Computer Science	Introduction to Computer Science Course
[14]	Alsobhi, A. Y., & Alyoubi, K. H. (2019)	DAELMS-System	Adaptive Hypermedia and Web-based	Social Sciences	Training course to help with dyslexia

Table 3 Participants, Evaluation Methods and Results

No.	Author (Year)	Participants	Evaluation Method	Country	Relationship with RQ	Results and Effects
[32]	Lu, Y., Pian, Y., Chen, P., Meng, Q., & Cao, Y. (2021)	School Students	Unit Test and experiments	China	RQ1,3,5,6	The researchers have developed a system that will serve over 6,000 students in local schools.
[39]	Qiu, D. (2018)	University Students	Unit Test, questionnaire and self-test	China	RQ1,2,3,4,5,6	The findings demonstrate that the mobile application is viable and that it contributes to the improvement of the design quality of the learning system of the ideological and political mobile learning system, which can also be popularized in practice in the future.
[7]	Al Rekhawi, H. A., & Abu Naser, S. S. (2018)	University Students	Questionnaire for ITS by group of teachers and group of students	Palestine	RQ1,2,3,4,5,6	The Droid-Tutor assessment greatly influenced the evaluators (Lecturers and students). They also urge that approaches be introduced for additional courses. They talked about the importance of the intelligent tutoring systems in the modern educational process.
[31]	Li, X. (2018)	University Students	Running Test and Performance Test	China	RQ1,2,3,4,5,6	This system improves ideological and political course teaching quality, increases teaching effectiveness, broaden the ideological and political education front.

[25]	Hoppe, L. V., Gembarski, P. C., & Lachmayer, R. (2021)	University Students	The automatic evaluation ITS with a special knowledge-based engineering system (KBES) and Students feedbacks	Germany	RQ1,3,5,6	The findings suggest that the created ITS fits the majority of the criteria for formative evaluation and may be used as such.
[13]	Alnajar, A. E. A., & Hanjory, M. (2017)	University Students	Questionnaire	Palestine	RQ1,2,3,4,5,6	DES-Tutor uses to help students learn cryptography and information security. An early assessment of the DES-Tutor by a group of instructors and students was conducted by the researchers, and the findings were positive.
[45]	Yang, Y. (2021)	School Students	Performance Test and Experiment	China	RQ1,2,3,4,5,6	The findings demonstrate that the actual system offer a highly automated platform for managing the school multimedia network-teaching. The approach improves the efficiency and accuracy of the teaching team.
[26]	Kadhim, M. K., & Hassan, A. K. (2020)	University Students	Pre-test, Post-test and Exams	Iraq	RQ1,2,3,4,5,6	Using the system to track students' grades, results, and learning activities. This indicates the improvement of performance of the students.
[18]	Bernard, E. C., Bernadine, O. I., Ngozi, E. B., Okechukwu, O. C., & Amara, O. J. P. (2020)	University Students	Questionnaire and Pre-test	Nigeria	RQ1,2,3,4,5,6	This system meets students' particular learning needs while also improving academic achievement.
[4]	AbuEl-Reesh, J. Y., & Abu-Naser, S. S. (2018)	University Students	Questionnaire and Exams	Palestine	RQ1,2,3,4,5,6	The questionnaire result has shown that intelligent tutoring systems have a favorable influence on learning and that further intelligent tutoring systems should be developed for other courses.
[43]	Wei, M. (2022)	University Students	Questionnaire Interactive Q and A,	China	RQ1,3,5,6	According to the research findings, the suggested algorithm aids in determining the significance and perspectives of ITS and entrepreneurship education.

[11]	Almurshidi, S. H. (2017)	University Students	Questionnaire	Palestine	RQ1,2,3,4,5,6	A panel of teachers, students, and doctors with expertise in this field evaluated the system. Each group's outcomes were quite satisfactory.
[19]	Bernard, J., Wainman, B., Walker, O., Pitt, C., Bayer, I., Mitchell, J., . . . Sonnadara, R. (2021)	University Students	Questionnaire, OSPE Questions and Exam Questions	Canada	RQ1,3,5,6	The tool achieved an average accuracy of 96.8% (SD = 3:4%) across 60 questions using responses from 428 trainees.
[8]	Al-Bastami, B. G., & Abu-Naser, S. S. (2017)	University Students	Questionnaire and Exams	Palestine	RQ1,2,3,4,5,6	The researchers asked a group of instructors and students to try the C# ITS. The overall impression of both students and instructors was positive.
[15]	Aparicio, F., Morales-Botello, M. L., Rubio, M., Hernando, A., Muñoz, R., López-Fernández, H., . . . Buenaga, M. D. (2018)	University Students	Questionnaire	Spain	RQ1,2,3,4,5,6	According to the findings of this research, the integration of credible sources of information, bilingualism, and selective annotation of ideas were the most appreciated qualities by instructors, who also thought that incorporating these systems into learning activities may be highly valuable.
[42]	Tafazoli, D., María, Parra, E. G., & Abril, C. A. H. (2019)	University Students and Students interested in learning languages	Questionnaire, evaluates students' responses and gives feedback	Spain	RQ1,2,3,4,5,6	The paper demonstrates the importance of intelligent tutoring systems in teaching and learning languages.
[34]	Mohamed, H., & Bashhar, B. (2017)	School Students	Questionnaire and Exams	Palestine	RQ1,2,3,4,5,6	The assessment findings revealed that students and instructors appreciated the system and thought it was highly valuable for them and their academic study.
[38]	Putra, A. B. N. R., Insani, N., Winarno, A., Puspitasari, P., Kiong, T. T., Habibi, M. A., . . . Subandi, M. S. (2021)	University Students	Questionnaires, Observations and Expert Testing	Indonesia	RQ1,2,3,4,5,6	Innovation of intelligent system e-consultant learning produced may be employed as an alternative learning medium. This ITS encourages a growth mentality, which might inspire students with limited

						talents to flourish in a learning setting.
[40]	Samra, H. E., Li, A. S., Soh, B., & Alzain, M. A. (2017)	University Students	Questionnaires and student performance evaluation	Australia	RQ1,3,5,6	The proposed model aims to present effective educational data mining methods and techniques that can be used to explore and analyze student educational data in order to gain a better understanding of the student's performance.
[30]	Laaziri, M., Benmoussa, K., Khoulji, S., & Larbi, K. M. (2018)	University Students	Questionnaires	Morocco	RQ1,2,3,4,5,6	The integration of modern learning technologies, such as ITSs, with university staff's everyday management tools is a significant challenge today.
[16]	Bakeer, H. M. S., & Abu-Naser, S. S. (2019)	University Students	Post-test and Exams	Palestine	RQ1,2,3,4,5,6	The study reveals the importance of the English language and the completion of the TOEFL exam, especially for master's students, as a prerequisite for graduation
[46]	Zhang, X., & Cao, Z. (2021)	University Students	Questionnaire	China	RQ1,2,3,4,5,6	Via trials, the suggested framework was shown to be effective and quick. The findings of the study broaden the scope of deep learning's applicability in education.
[22]	Fang, Y., Lippert, A., Cai, Z., Chen, S., Frijters, J. C., Greenberg, D., & Graesser, A. C. (2022)	Adults with Limited Reading Literacy	Pre-test and Post-test	China	RQ1,2,3,4,5,6	This research implies that in future investigations, clustering strategies might be employed to improve the adaptivity of ITS. AutoTutor assist the adults in improving their reading comprehension abilities.
[36]	Nakhal, M., & Bashhar, B. (2017)	University Students	Questionnaire and Exams	Palestine	RQ1,2,3,4,5,6	In terms of usability and learning capacities, a review of the ITS indicated relatively acceptable results.
[20]	Cao, F., Xiang, M., Chen, K., & Lei, M. (2022)	University Students	Fuzzy-Based Evaluation and Events Tracing	China	RQ1,2,3,4,5,6	This article establishes a new era of updating educational activities using computerized quality education for

						AI technology. The experimental findings in detecting university students' frequent activity are promising.
[37]	Ognjenovic, P. (2017)	School Students	Questionnaire, Pre-test and Post-test	Croatia	RQ1,2,3,5,6	ITS systems in the educational process are considered a catalyst for students to increase their academic achievement, as the results of using the AC-Ware Tutor exceeded expectations
[23]	Hasanein, H. A. A., & Abu-Naser, S. S. (2018)	University Students	Questionnaire and Exams	Palestine	RQ1,2,3,4,5,6	After reviewing this ITS, we are certain that employing the ITS is significant in the development of laboratory instruction and has a favorable impact on the level of the scientific student.
[29]	Kochmar, E., Vu, D. D., Belfer, R., Gupta, V., Serban, I. V., & Pineau, J. (2022)	University Students	Questionnaire and Experiments	Canada	RQ1,2,3,4,5,6	The tailored feedback mechanism is employed in Korbit with over 20,000 students. The findings of studies with students demonstrate that automated, data-driven, individualized feedback leads to a considerable overall increase in student performance outcomes
[9]	Aljameel, S. S., O'Shea, J. D., Crockett, K. A., Latham, A., & Kaleem, M. (2017)	School Students with autism (10 to 16 years old)	Questionnaire, Pre-test and Post-test	Saudi Arabia	RQ1,2,3,4,5,6	The Lana system had an impact on developing the abilities of school students in Saudi Arabia who suffer from autism
[35]	Mosa, M. J., Albatish, I., & Abu-Naser, S. S. (2018)	Interested Students with Web Development by ASP.NET	Questionnaire and Exams	Palestine	RQ1,2,3,4,5,6	The teachers and students evaluated this tutor and the results were excellent by students and teacher.
[44]	Wolfe, C. R., Reyna, V. F., Widmer, C. L., Cedillos-Whynott, E. M., Brust-Renck, P. G., Weil, A. M., & Hu, X. (2016)	Adult Women	Control group and Experimental group with Pre-test and Post-test	United States	RQ1,2,3,4,5,6	BRCA Gist outperformed controls considerably. The effectiveness of gist explanation dialogues is shown by significant variations in knowledge, understanding, and fine-grained conversation analyses.
[12]	Almurshidi, S. H., & Naser, S. S. A. (2017)	University Students	Questionnaire	Palestine	RQ1,2,3,4,5,6	The system's evaluation revealed rather good findings

						and beneficial impacts in terms of its learning capabilities and usability.
[3]	AbuEloun, Nour N. & Abu Naser, Samy S. (2017)	School Students	Questionnaire	Palestine	RQ1,2,3,4,5,6	Following the questionnaire, the majority of students said that the Mathematics ITS makes it simpler for them to study and that it is extremely efficient in terms of the content and exercises, as well as the difficulty levels of the questions.
[24]	Hiles, M., & Agha, M. (2017)	University Students	Questionnaire and Exams	Palestine	RQ1,2,3,4,5,6	The learners praised the MDB system's versatility, as was the learning style. And it had an impact on learning the database course
[33]	Marouf, A., Yousef, M. K. A., Mukhaimer, M. N., & Abu-Naser, S. S. (2018)	University Students	Questionnaire	Palestine	RQ1,2,3,4,5,6	An initial evaluation study was conducted to examine the impact of employing the intelligent tutoring system on the performance of computer science students at Al-Azhar University in Gaza. The findings had a beneficial effect on the assessors.
[14]	Alsobhi, A. Y., & Alyoubi, K. H. (2019)	University Students with dyslexia	Questionnaire, Pre-test, Post-test for control group and experimental group	Saudi Arabia	RQ1,2,3,4,5,6	According to the results of the questionnaire and the post-exam, there was a significant improvement for students who suffer from dyslexia

2.6 RESULTS AND DISCUSSION

2.6.1 Publication Years

The results of the study show that most of the research selected after PRISMA Methodology and the application of exclusion and inclusion criteria were in the period between 2017 and 2018 in addition to the year 2021(see Figure 4 for Publication Years and Table 1 for Data Extraction).

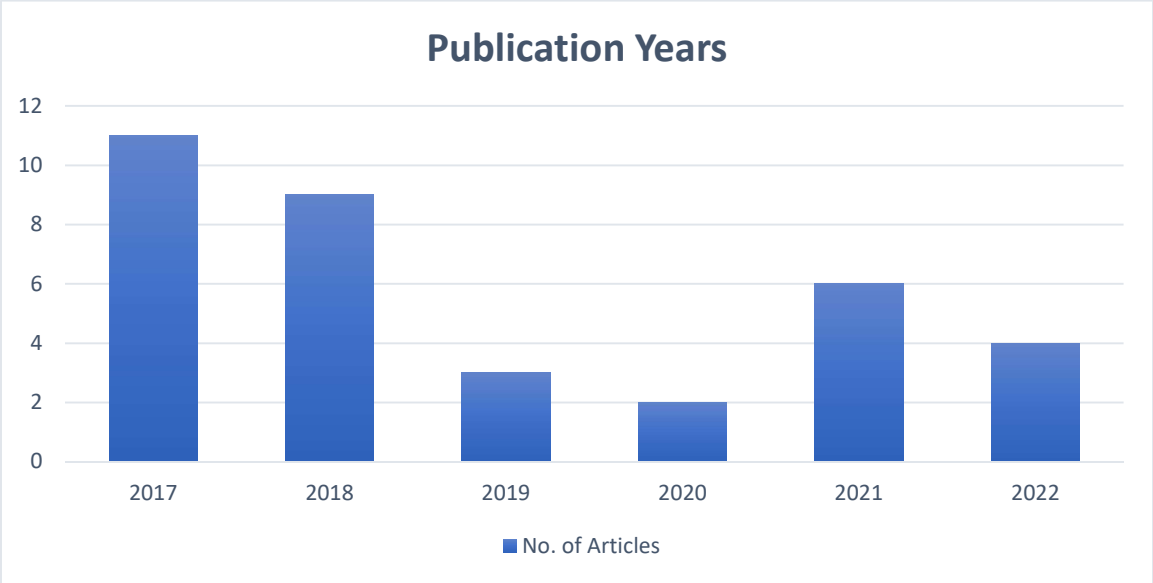

Figure 4 Publication Years

2.6.2 Articles Source, Articles Type and Country

The percentage of research selected in this study was from the Scopus and Web of Science databases, 61% of the researches and 39% of the research from Google Scholar (see Figure 5 for Articles Source and Table 1 for Data Extraction).

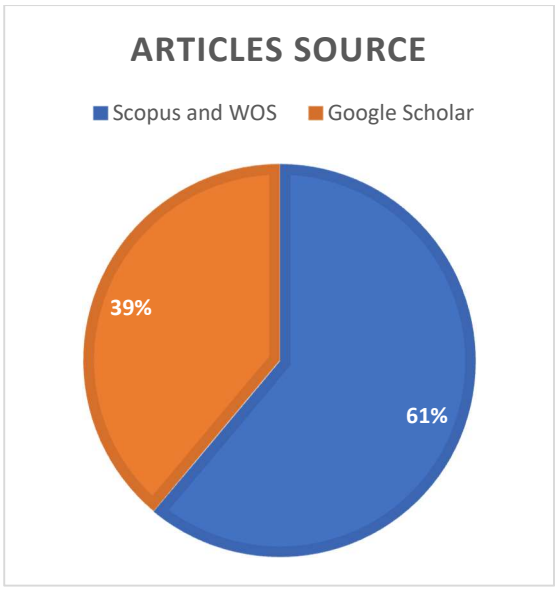

Figure 5 Articles Source

Most types of research were concentrated in journal research, representing 78%, and conference papers 22% (see Figure 6 for Articles Types and Table 1 for Data Extraction).

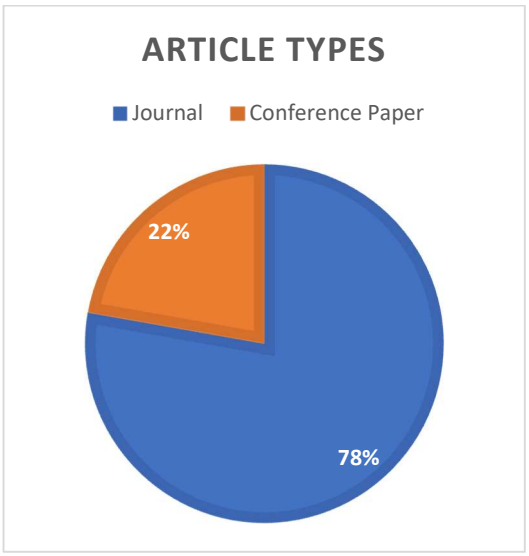

Figure 6 Article Types

The study also mentioned the countries in which the selected research was applied, and Palestine and China were among the most included countries in the study, in addition to other countries such as Canada, Saudi Arabia, Spain and many countries (see Figure 7 for Research Country and Table 3).

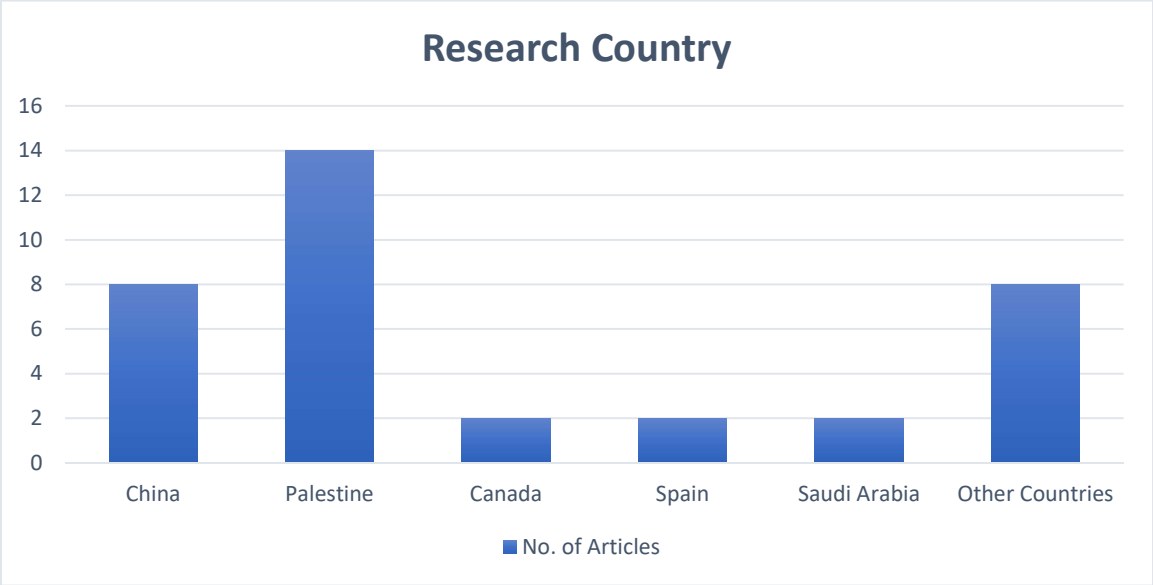

Figure 7 Research Country

2.6.3 Tools and User-interface Used in ITS

Some of the intelligent tutoring systems included in this study were developed through some web and mobile software and interfaces that require a development team, and others are implemented through the implementation of the system using ready-made tools such as ITSB, Auto-Tutor, and other tools without the need for an expert in the field of software development. Whereas the percentage of research that used ITSB from the study was 38%, web-based systems were 25%, and the share of mobile-based applications was the lowest (see Figure 8 for Tool used in ITS and Table 2).

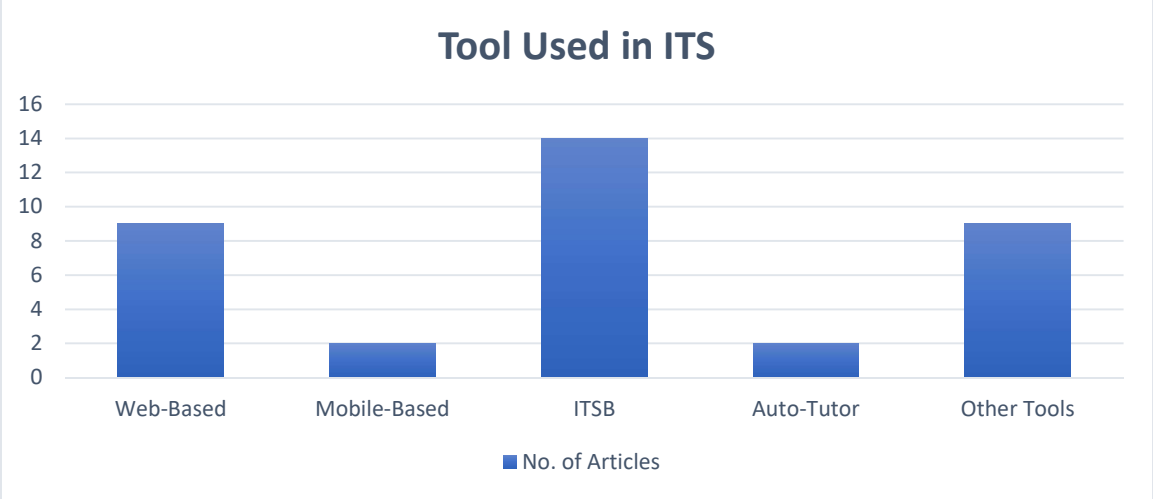

Figure 8 Tool used in ITS

2.6.4 Education Fields and Participants

In this study, intelligent tutoring systems were applied in various educational fields, most of which were Computer Sciences, as the percentage of 36.1% were the most common educational fields in ITSs. And Social Science, Medicine, Engineering, and Mathematics, with 27.7%, 13.8%, 8.3%, and 5.5% frequency, respectively (see Figure 9 for Education Fields of ITS and Table 2).

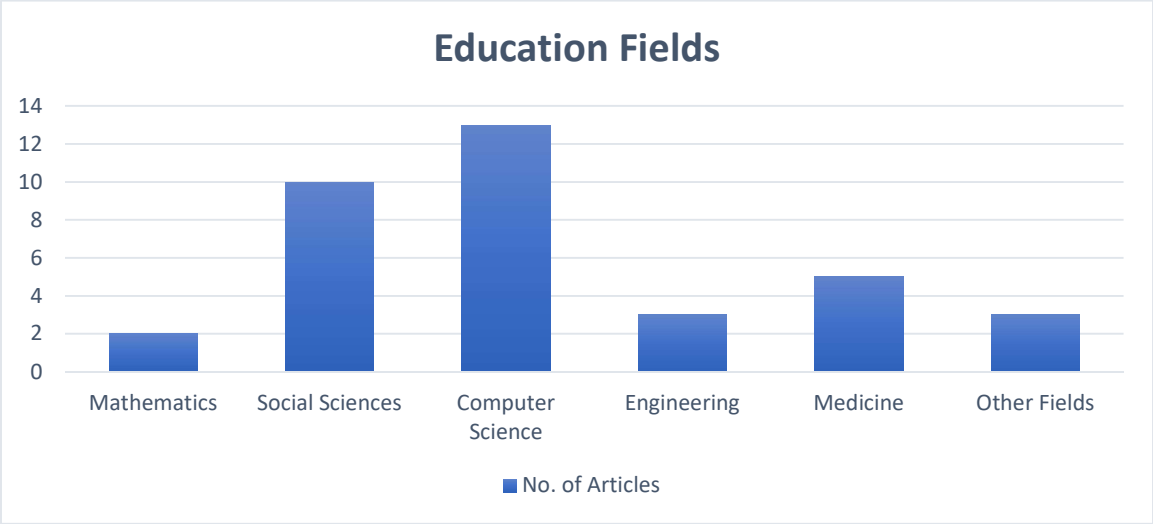

Figure 9 Education Fields of ITS

The majority of participants in intelligent tutoring systems, students, were 67% university students, while the percentage of school students reached 19% (see Figure 10 for Participants of ITS and Table 3).

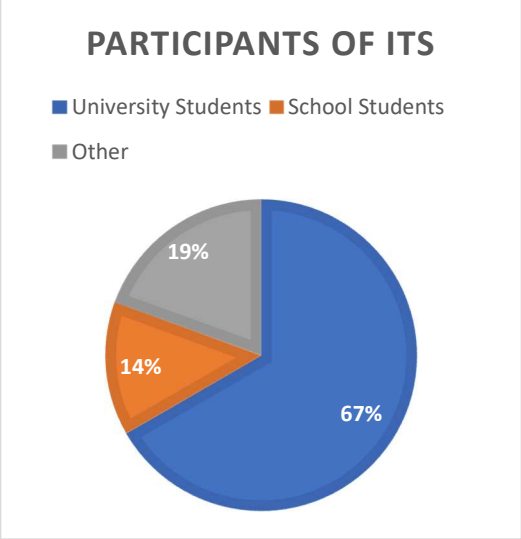

Figure 10 Participants of ITS

as a 26 % rating tool, there was a unit test and the performance test for some ITS to ensure its software quality (see Figure 11 for Evaluation methods of ITS and Table 3).

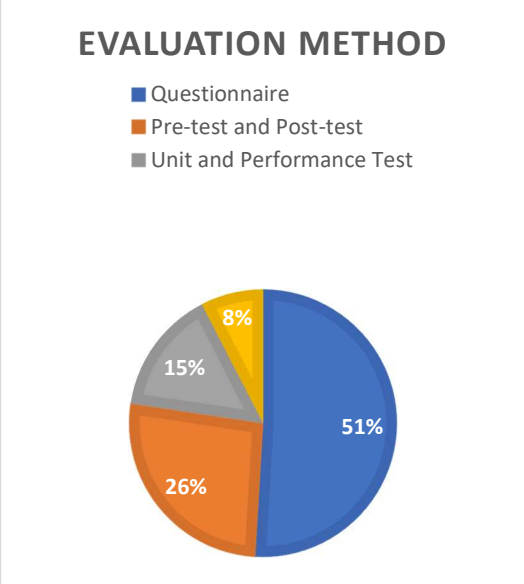

Figure 11: Evaluation methods of ITS

2.6.5 Evaluation Methods

Various methods have been used in the evaluation process, as there is an evaluation of the intelligent tutoring system through questionnaires and an evaluation of the learner student through the pre-test and post-test. The percentage of intelligent tutoring systems that used questionnaires as a means of evaluation of 51 %, which shows its importance in the process of evaluating the ITS. While the percentage of ITS that used the pre-test and post-test

2.6.6 The effects of using ITS in Education

The intelligent tutoring systems used in various fields of education had a significant effect on increasing the educational attainment of most students, especially university students, in addition to encouraging students to self-study and giving them sufficient motivation for that, in addition to being an important reference for their information. The ITS ensure the availability of a teacher for each student who takes into account individual

differences and adapts to students' levels. In addition to ensuring that students are evaluated and evaluated at every stage of the teaching content (see Table 3 for the effects of ITS in Education).

2.7 CONCLUSIONS

The study focused on research in the years 2016 and 2022, and computer science was one of the most areas in which intelligent tutoring systems were applied in their courses, in addition to social sciences, medicine and other fields. It explains the importance of intelligent tutoring systems in the educational process and their superiority over traditional education methods.

Most of the intelligent tutoring systems that were reviewed used web interfaces in the development process, in addition to utilities such as ITSB, Auto-Tutor, and others. Also, most of the participants in the intelligent tutoring systems were university students, and this confirms the importance of applying ITS in the various courses in universities.

ITS was evaluated in a variety of ways, the majority of which employed learner-centered methodologies such as pre-and post-tests. Furthermore, the major way of evaluating ITS via experts and questionnaire was system performance and unit test.

Due to their scarcity, the research advocated the deployment of mobile-based intelligent tutoring systems, since mobile is an integral component of our everyday lives.

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