UNIVERSIDAD AUTÓNOMA DEL ESTADO DE QUINTANA ROO

DIVISIÓN DE HUMANIDADES Y LENGUAS

Elaboration of an English-Spanish glossary of terms related to Artificial Intelligence in Education

Monografía en la modalidad de Investigación Documental

Para obtener el grado de
Licenciada en Lengua Inglesa

PRESENTA
Jazmín Rodríguez Calderón

ASESORES
M. C., José Luis Borges Ucán

Dr., Alfredo Marín Marín

M. A., María Isabel Hernández Romero

UNIVERSIDAD AUTÓNOMA DEL ESTADO DE QUINTANA ROO

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COMITÉ DE SUPERVISIÓN

Asesor: M. C. José Luis Borges Ucán

Asesor: Dr. Alfredo Marín Marín

Asesor: M. A. María Isabel Hernández Romero

Suplente: MTI. Melissa Blanqueto Estrada

Suplente: Dr. Oscar Manuel Narváez Trejo

Chetumal, Quintana Roo, México, octubre de 2022

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ABSTRACT

This monographic work, which is presented as a bilingual English-Spanish glossary, is a compilation of terms related to the field of Artificial Intelligence in Education (AIED) that aims to serve as a reference tool for students, educators, researchers, and translators. It contains a total of 200 alphabetically ordered terms of common use in the field, which were originally found in the English language and then added with their Spanish equivalent. It should be noted that for a better understanding of the reader, a contextualization of each term is provided, i.e., small fragments of text from which the words were extracted for the compilation. Due to the great development of technology and its impact on the education sector, terms arise that may be unfamiliar to those who are interested in reading or doing research in the area of artificial intelligence in education. Therefore, the main objective of this glossary is to contribute to the understanding of specialized terms for those involved in an educational environment and translators.

I. INTRODUCTION

Since the emergence of artificial intelligence (AI), the belief that a better world is coming is becoming more real every day. The projection of ideas about personalized robots with human capabilities was part of the science fiction envisioned in the distant future. Nonetheless, cases in which AI is used are more common than it seems, as in our daily lives we often make use of machines that mimic human cognitive functions and perform human intelligence tasks. An example of the applications in everyday living is the classification of emails, this is a function of AI since its services are responsible for directing the location of emails to important, social, or spam folders which makes it easier for the cybernaut to find a specific email. Another application is the use of search engines such as Google, Yahoo Search, Microsoft Edge, Bing, among others that allow us to search for information during the day, as well as offer us advertising with the information collected about us being a personalized service. Thanks to computer programs, AI has been able to solve certain types of problems, analyze information and provide answers, adapt to an environment, and learn from experience as a person would do.

In 1950, Alan Turing published his famous article Computing Machinery and Intelligence in which he proposed the idea of the "Imitation Game" which consisted of the individual having to discover whether the person speaking was a person or a machine in a teletype dialogue. Later this proposal became known as the "Turing Test" and was cited as the starting point for questioning the boundary between a machine and a human being. From there, a series of technological developments began. Finally, in 1956, the term Artificial Intelligence was coined for the first time during the conference at the Dartmouth College. The official invention of the word was attributed to John McCarthy and defined by Marvin as "the construction of computer programs that engage in tasks that are currently more satisfactorily performed by human beings because they require high-level mental processes such as: perceptual learning, memory organization and critical reasoning" (Council of Europe, n.d).

Likewise, the subject of AI is controversial and generates a division of opinions about the role of human beings in a new era. There are those who perceive this advance as support for society and one more achievement of human intelligence, but there is also an approach that places new technologies as a future threat. One of these approaches comes from one of the creators of the AI concept, Marvin Minsky, whose thought was based on the fact that computers will take control even of humanity since they reflect about our actions in an evolved way. Conversely, the hope of coexistence between machines and human beings allows great leaders such as Satya Nadella, CEO of Microsoft, to reflect on values that no computer can add as he mentions that "real intelligence, real empathy, and common sense will be scarce" so it should encourage the unique capabilities of human beings and knowledge to work with machines (Iglesias, 2020).

So far it can be understood that artificial intelligence is about programs, computers, technology, and imitation of human beings to perform tasks, but what is it really about? Although there is no concrete definition of AI, we can understand that it refers to the ability of machines to acquire and apply knowledge and to perform intelligent behaviour. This means performing a wide variety of cognitive tasks, e.g., perceiving, processing spoken language, reasoning, learning, making decisions, and demonstrating the ability to move and manipulate objects accordingly (Kayssi, 2019).

Today, thanks to the developers of technology, various spheres of society have benefited from its impact and one of them is education. The advancement of IA makes teachers' work and students' learning more dynamic, transforming educational institutions more efficient in their curricula. Elements of AI that have caused an improvement in teaching are utilization of big data processing, education informatization 2.0 i.e. Implementation of IT into educational process with AI aspects and personalized learning – based on construct learner profile (Pikhart, 2020). The use of AI allows those involved in an educational environment to have a new perspective on teaching and learning, as the way teachers do their job will be strengthened as well as the way students learn. Artificial Intelligence in Education (AIED) facilitates the creation and design of learning activities with the help of computer programs that enhance the learner experience. Such applications have the ability to observe the learning process, analyze the student's learning performance and provide assistance based on their needs (Hwang et al.,2020).

Although it seems that AI has been very helpful in teaching, the work of teachers should not be underestimated as it is not about replacing them but highlighting their multifaceted role in education, as skills such as empathy, personal relationships or collaborative work cannot be taught under the guidance of AI technologies. Therefore, the importance of basic knowledge and skills for the use of AI in a pedagogical and meaningful way, in order to cooperate and create connections of everyone involved in the educational context such as AI programmers, developers, companies, schools (European Parliament, 2021).

For that reason, the mission of the institutions is that students and teachers can interact in a safe environment thus generating a quality education with the use of technology that highlights the advancement of IA. This advance should aim to improve human sufficiency and protect human rights through a focus on human-machine interaction (UNESCO, 2021). In this way, more people can benefit from educational programs and reduce difficulties in access to learning. Indeed, supporting teaching is becoming more present through new technologies that are being integrated into training programs for students and optimizing teaching methods that change the traditional teaching system.

Georgia is one of the countries seeking to contribute to a virtual environment where teachers and students can benefit from using learning assistance. To that end, Jill Watson Q&A, a virtual teaching assistant was developed in 2016 that helps improve student engagement by answering questions. Online learners interact in the discussion forums by posting messages and questions to which the teaching assistant immediately produces answers classified in categories within its digital library (Goel & Polepeddi 2017, 2018, as cited in Goel, 2019). This makes it easier for teachers to work with the help of AI, as they can have more time to go deeper into the automated answers and improve their students' understanding.

It is a fact that artificial intelligence has not only developed in different areas but also it has had an impact in many countries, one of them being México. According to Zapata and Gómez-Mont (2020), in 2017 México adopted a proactive approach that focused on setting an international stage where the future of AI is catalyzed. It is worth mentioning that México is one of the most digitally progressive governments in the world and is recognized by the OECD as a leading country in creating impact through the reuse of open data. Therefore, its strategy seeks to improve the quality of all sectors to increase their efficiency by focusing on education through

the presentation of codes, computer skills, and science, among others. Technology in education is an important element to enrich knowledge and should have a positive influence on the student, but it would be even better if the educational institutions have technological resources that can improve the teaching-learning of those in the academic environment.

1.1 Rationale

Today, the growth of artificial intelligence is being witnessed in many areas of our lives. Due to the speed of technological innovations, constant changes in this digital era arise and bring about the emergence of tools that facilitate our lifestyle, however, such changes apply to other sectors such as education, which is already using new technologies due to the current situation. After the confinement by COVID-19, the application of AI within education was gradually integrated, students can now study at their own pace without having to physically attend class. In terms of homework, it is now possible to set up applications that provide problem-solving and feedback for the student to develop skills and identify strengths and areas of opportunity.

Every learner has a different pace and style of learning, which is caused by a variety of factors that can influence learning positively or negatively. In the face of these gaps that affect learning, AIED analyzes them and offers step-by-step solutions to complex problems to support the learner (Chaudhry & Kazim, 2021). Therefore, there are applications that address the needs of the students; however, they are programmed with a special function that can be adapted to a field of study or an academic level, so it varies depending on the user's information. For example, students who need to learn another language may have used Duolingo, Babbel, or Wibbu which are personalized learning applications. Their algorithms adapt to the learner's needs and provide feedback in an innovative and fun way, making the teacher's job easier. Other applications are used for proofreading. Writing assistants such as Grammarly are useful for correcting spelling and grammar and suggesting expressions that improve the author's writing. Google Lens is another application used by students through image recognition and processing. It allows them to search for information and find results on any topic on the Web.

On the contrary, the AIED seeks to benefit teachers by decreasing their overload without intervening in their learning objectives (Chaudhry & Kazim, 2021). However, teachers must be advised on the use of new technologies in the classroom and thus adapt to a new era where their role is important, as they must foster learning environments with human experience and interaction. According to Chaudhry & Kazim (2021) having basic knowledge of digital tools allows "to develop analytical skills to interpret the data that are visualized by these ed-tech tools and to identify what kind of data and analytics tools they need to develop a better understanding of learners". As mentioned above, the aim is not to replace teachers but to support them in the face of evolving technology, so that students and teachers are the ones who enjoy the benefits of AIED. Karandish (2021) mentions "AI has the power to optimize both learning and teaching, helping the education sector evolve to better benefit students and teachers alike". For that reason, new technologies need to be part of education in order to improve the teaching-learning process.

Considering this context, the emergence of new terms that may be unfamiliar to students and teachers involved in the field of artificial intelligence requires the use of a more technical language in certain situations. Furthermore, because the topic of artificial intelligence in education is a current issue, there is no glossary on the subject in the library of the Universidad Autónoma del Estado Quintana Roo making this work necessary. On the web, it is possible to access glossaries focused on the same topic such as: "AI Glossary: Artificial intelligence, in so many words", by Matthew Hutson in 2017. His work shows us a compilation of terms speaking in a general context of artificial intelligence. While "A preliminary glossary of artificial intelligence in radiology" by Pakdemirli in 2019, defines the most common terms in the discipline of radiology for the benefit of its practitioners. This shows that glossaries on artificial intelligence do exist, however they are not precisely oriented toward the educational sector. This need leads us to the main contribution of this glossary, which is to provide a total of 200 updated terms as a bilingual resource to students who wish to carry out academic work related to AIED and require precise information about a concept. Likewise, professors who teach subjects related to artificial intelligence can benefit from this work to facilitate explanation and translation in their teaching. Possibly, this glossary can also be used by researchers and translators who need to consult AIED terminology for future research work.

Additionally, this proposal can benefit students of the network engineering degree, as they study subjects such as Artificial Intelligence according to their syllabus taken from the official website of the Universidad Autónoma del Estado de Quintana Roo, which clarifies the development of competences and skills in the undergraduate degree section. The official website of the Universidad Autónoma del Estado de Quintana Roo, (n.d.), indicates that professionals must master "the whole process of design, construction, programming, and implementation of computer and computer networking solutions". In addition, they must be able to adapt to technological changes and offer effective solutions. Taking into account the above, this glossary could serve as a reference in academic and work-related work for both students and teachers who teach the subjects corresponding to this undergraduate program.

The need to create a bilingual glossary arises from the idea that terms such as *chatbots* or *deep learning* are included in Spanish articles without having an equivalent. This could lead to complications in understanding certain readings. For this reason, this monographic work aims to compile a list of vocabulary that is frequently found in various AI sources, as well as a contextualization of where the terminology is applied, which is expected to support translation work. This glossary is also available for students and teachers who teach languages at the Universidad Autónoma del Estado de Quintana Roo, who may be exposed to AIED terminology when using personalized tutoring applications for learning languages such as English, French, German, Portuguese or Italian. It is likely that teachers in their courses may make use of educational resources that require artificial intelligence; therefore, they may encounter English concepts in their teaching strategies such as finding solutions focused on skills reinforcement with the help of virtual assistants to provide automated feedback to students on pronunciation or to provide exercises to practice grammar.

Even teachers from other academic institutions who wish to take courses on the use of digital tools may find this glossary useful, as the intention to apply new innovative strategies in their classrooms will force them to deal with terms that may be unfamiliar without prior knowledge of the language used in this area. Based on this idea, this glossary can provide a list of current terms with their contextualisation to familiarize education sector participants with unfamiliar AIED concepts.

One factor that benefits this work is location. The state of Quintana Roo is one of the regions with the highest influx of foreign visitors; therefore, English is required in certain occupations, especially in tourist areas. However, Mexico is one of the countries with a very low level of English language, according to EF EPI (2020) it is in the 92nd position. These results show a lack of English proficiency, which is unfortunate because it is important for economic and technological competitiveness. In support of this problem, the glossary can be used in this region as long as it is applied in situations that require definitions of AIED terminology.

1.2 Objectives

For any research, it must establish the objectives before writing. It is therefore an essential component. This section describes the specific objectives that gave direction to this study. As mentioned before, this bilingual glossary is a compilation of common terms used primarily in the area of AIED and its main objective is to provide a reference tool for students and teachers who require a translation or equivalent in Spanish of the concepts commonly used in this field.

After presenting the general objective of this glossary, the specific objectives that are intended to achieve with this study are the following:

❖ To create a novel bilingual glossary accessible to anyone who needs to become familiar with AIED-related concepts.

❖ To provide a context for each word extracted for a better understanding of its usage.

❖ To denote AIED terminology for translation articles or assignments from researchers and translators.

❖ To follow a methodology for the creation of a glossary with technological tools for other students who are interested in creating a bilingual glossary.

II. LITERATURE REVIEW

This monographic work belongs to the documentary research category since the aim is to compile a collection of terms through an extensive search of information in documentary sources such as magazines, books, newspapers, research articles, etc., in order to carry out an analysis. First, it is necessary to consider the definition of documentary research, according to Bayle (1994, as cited Mogalakwe, 2006), "the use of documentary methods refers to the analysis of documents that contain information about the phenomenon we wish to study "(p. 221).

For the selection of the terms, the researcher had to review of different documents concerning AIED to connect with the topic, as there must be a mastery of knowledge of what is to be investigated for making an exemplary glossary. Databases were very useful in the literature search by consulting primary sources where the author is specialized in the topic of artificial intelligence. Therefore, keywords such as "Artificial intelligence in education", "AIED", and "AI applications in education" were utilized, which yielded the highest number of results during the search. For the bibliographic search, databases such as Google Scholar, Springer, Scielo, etc. are useful resources to consult for information, as well as collaborative sites of scientists and researchers such as ResearchGate.

It is important to mention that if the researcher does not have any relation to or is unfamiliar with the topic to be investigated, there will be difficulties in identifying the correct terms, that is why it is recommended to read books, journals, and research papers that are current in order to understand the context of the terminology and make a good selection.

Foremost, the difference between term and terminology must be clarified, both concepts are mentioned in this glossary, however, it could be understood from another perspective by the reader. Everyone has a subjective idea about the meaning of a term, which may allow them to interpret it as a classification of words within a field of study. Although this reasoning is not far from the definition given by Voznjuk et al. (2010, as cited in Vakulenko, 2014), which explains

term "as a word or collocation that coordinates with a clearly defined concept of a science, technology, art, social and political life and enters into a systemic relationship with other similar units of language, forming with them a particular system, or terminology".

In respect of terminology, which is what this glossary aims to compile, it can be understood as a set of words belonging to a discipline or specialty. According to Lejchick (1994, cited in Vakulenko, 2014), terminology can be defined as "a set of linguistic (lexical) units denoting the concept of a certain specialized field of knowledge or activity that is spontaneously shaped during the birth and development of this field" (p. 7). Having defined both concepts, the reader will notice the difference between them and understand the usage of each one.

Now, accurate research requires a literature review to support and argue with clear ideas on a particular topic, it is to build knowledge through the findings of other researchers. According to Western Sydney University Library (2017), the purpose of a literature review is to gain knowledge from existing research and debates centred on a specific topic or area of study and to capture that knowledge in the form of a written report. The writing style must be clear and precise, the author must express his or her personal ideas so that the work is not considered plagiarism. For a better understanding of the reader, it is advisable to be open to suggestions of correction by authors who know more about the subject and also those who do not, in order to verify the congruence of the writing. Revision is fundamental in the writing process, the writer has to re-read, refurbish, receive feedback, and go over it many times (Johnson, n.d). In this way, reading and writing will be easier for the researchers, who must take on the role of lector at the same time in order to understand their own redaction.

The terms listed in this glossary are defined so that the user can become familiar with the definitions provided and can be useful as a reference. The alphabetical order of the terminology makes it easier for the reader to search for each word and should address the need for information on new terms with clear and understandable definitions. Each glossary is particularized in a subject depending on the author's interest, so the objectives to be achieved vary. Like dictionaries, glossaries are based on defining concepts. A glossary is an alphabetical list of words, accompanied by definitions, intended to help readers understand specialized terminology they may not understand (Proofed, 2021). With the creation of this glossary, it is planned that

users will understand the technical language used especially in education in the area of artificial intelligence.

It should be emphasized that each author follows his own strategies and methodology for the elaboration of a glossary. Hence, several glossaries and dictionaries on the subject of artificial intelligence were consulted. The following example was produced by cooperation between the Sino-German Company Working Group on Industrie 4.0 and Intelligent Manufacturing (AGU) Expert Group Artificial Intelligence in 2015.

The subject of their glossary focuses on the AI terminology used in the manufacturing industry as digitalization has reached and even impacted the way companies and their employees work. In view of this, the publication seeks to answer: How can AI be efficiently applied in the manufacturing industry as well? Therefore, it provides 84 terms containing summary information explaining keywords related to AI technologies in industry.

Within its objective, it states that it wants "to develop a joint understanding and to give a comprehensive overview of what AI involves, which technologies it contains as well as the relevance to Industrie 4.0 and Intelligent Manufacturing " (Hui et al, 2015, p. 1). The glossary was primarily intended for employees, manufacturing company units and other consultants who wish to have information in this area. The terms are translated into the Chinese language and classified into five categories: 1. AI Techniques, 2. AI Subarea, 3. AI Functional Applications, 4. AI Application Fields (restricted to the areas of Intelligent Manufacturing that are enabled by AI) and 5. Other basic terms. The interesting fact about this glossary is that in addition to defining the terms in the form of short explanations, it mentions the relevance of each term to the area of application in Industrie 4.0 and Intelligent Manufacturing (see Table 1).

Table 1

Example of glossary format of AI Glossary

Index No.	Classification	Index Term	Term Variants, Abbreviations, Long Forms	Chinese Term	Short Definition in Simple Language	Relevance for Industrie 4.0 and Intelligent Manufacturing
19	AI Techniques Other basic terms	Common-Sense Knowledge	N / A	常识性知识	In Artificial Intelligence, common-sense knowledge is the set of background information (facts) that an individual is expected to know and the ability to use it when needed. It is a shared knowledge (between everybody or people in a particular culture or age group only).	By abstracting common sense knowledge from industrial processes, producers can use established data to bring in known mechanisms, enabling machines to have the ability to solve known problems.

Source: Adapted from Hui, A. et al., 2015.

Although the glossary is not intended to contribute to a scientific community as its direction of study is different from the educational sector, it plans to offer a resource that will be

useful to small and medium-sized manufacturing companies to improve their working environment in the face of technological developments. For the literature, books and websites in the field were used to obtain results due to the accessibility of the sources. The format of the glossary facilitates its use as the concepts are in alphabetical order and are found within their corresponding category. What makes it easier for the user is the explanation of the relation of the concept with the area, as it is not very common to see it in other glossaries.

In addition to this example, "A preliminary glossary of artificial intelligence in radiology", a glossary developed by Emre Pakdemirli in 2019, was consulted. It aims to present a terminology to serve as a reference for more experienced practitioners and radiologists who are interested in IA (Pakdemirli, 2019). Compared to the previous glossary, both mentioned that their research was not as exhaustive as they only presented the most commonly used concepts in their respective areas. In this case, the terms are presented in the form of a list in alphabetical order, where some AI terms outside the discipline of radiology were excluded, as well as some specific scientific terms. Here is an example.

Algorithm: Step-by-step instructions completed by computers, including simple or complex tasks, such as setting reminders or identifying a group of people within a crowd.

Backpropagation: The manner in which CNNs learn. They are able to recognize the differences between output and desired output and adjust calculations in reverse order of execution. (Pakdemirli, 2019, p.1)

As noted, both glossaries focused on artificial intelligence, however, their field of study is different from the present glossary. Moreover, the list they present is not that deep because some terms are too common to add, and they do not mention a detailed methodology.

In addition to consulting various glossaries on the Web, the author decided to review the copies in the library of the Universidad Autónoma del Estado de Quintana Roo, since they could provide an idea about their elaboration when analysed from their methodology and structure. The following were compiled by former English Language students belonging to the same university. *Spanish-English-Maya-Latin Glossary of the most commonly used medicinal herbs of the Mayan world*, elaborated by Karla Ariana Pech Razo in 2004, it states in the general objective: "to provide people with a trilingual glossary of medicinal herbs as well as to let them have a quick

access to specific names of herbs which are used nowadays and were part and parcel of the ancient Maya civilization" (Pech, 2004, p. 18). Her glossary of approximately 200 terms also considers those translators who require information on the natural medicine of Quintana Roo and Central America. Further, within her methodology she mentioned that she gathered information through interviews with native Mayan people, specialised books, and Mayan history books to obtain more accurate information. To facilitate the search for terms, the author included a user's guide to make the glossary more accessible. As for the placement of the terms, they were sorted alphabetically and placed in four columns (see Table 2).

Table 2

Example of glossary format of Spanish-English-Maya-Latin Glossary of the most commonly used medicinal herbs of the Mayan world

SPANISH	ENGLISH	MAYA	SCIENTIFIC NAME
Acedera: ayuda a bajar la hinchazón del cuerpo (crecimiento anormal).	Common Sorrel: Helps reduce body swellings (abnormal enlargement).	Abal Kan Elel	*Rumex Crispus*

Source: Adapted from Pech, 2004, p. 27.

The objectives of this glossary were satisfactorily fulfilled by having collected terms in order to contribute to those who require information in the field of herbal medicines. This work was complete because it takes a lot of effort and persistence to provide a trilingual terminology that allows the reader to gain knowledge about this specific area. Another example found was A *Spanish English glossary of the names for some typical dishes from the Yucatán Peninsula*, elaborated by Verónica Teresa Martínez Castillo in 2004. As its main objective she states:

To present a bilingual glossary of terms related to popular dishes in Yucatán cuisine, identified in Spanish and in English and arranged to show the variants and the place where each is the form most commonly used to refer to the dish (Martínez, 2004, p. 20).

It is notable that their main audience is English-speaking customers, since to order in a traditional regional restaurant they must distinguish the ingredients and mainly the names of the dishes. The researcher considered 300 typical dishes from Chetumal and Merida to highlight the contrast between their preparation and ingredients. In her methodology she explained that there was indeed a shortage of bibliography which made her compilation process difficult, however, the research was carried out in restaurants, bookstores, and libraries. To support the reader in understanding the origin of the dishes, a comparison section was included divided into six categories: Antojitos y salsas, Aves y carnes, Mariscos, Tamales, Sopas and Legumbres.

The glossary format is set up covering only the names of the dishes and is divided into two parts. On the left is the name of the cymbal used above in the comparison section, while on the right the English translation can be found. Like the previous glossary, it is arranged alphabetically (see Table 3).

Table 3

Example of glossary format of Spanish English glossary of the names for some typical dishes from the Yucatán Peninsula

Spanish	English
A	
Ajiaco	ajiaco [original recipe of the region, prepared with meat, vegetables, and rice]

Source: Adapted from Martínez, 2004, p. 142.

When reviewing the last two glossaries, the absence of a literature review was noticeable, as both of them presented a different structure to the present glossary. Also, the methodology applied in the previous examples was manual, without the use of any technological resources, which must have been complicated for the researchers. It is understood that both glossaries were compiled more than 10 years ago, so it is possible that there was no knowledge of the current software that benefits researchers. In view of this, it is necessary to take advantage of the technological advantages as new updates emerge every day that will become part of our lives. That is why this glossary seeks to contribute to those who need information on terms related to the field of AEID obtained with technological resources.

III. METHODOLOGY

For the elaboration of well-founded research, it is necessary to describe the methods and techniques used that allowed the collection of data for evaluation and credibility to the reader. Igwenagu (2016) defines methodology as:

> The systematic, theoretical analysis of the methods applied to a field of study. It comprises the theoretical analysis of the body of methods and principles associated with a branch of knowledge. Typically, it encompasses concepts such as paradigm, theoretical model, phases and quantitative or qualitative techniques. (p.4)

Methodology is understood as the set of procedures used for the elaboration of a study or research. In this glossary, this procedure was based on the glossary model, elaborated by

Mercedes López Santiago in 2019. Her glossary "*Proposal for a bilingual (Spanish-French) online glossary of architectural terms"* sets out the steps that allowed her to construct her list of terms about floating architecture in order to contribute to the translation of the field of architecture. As for the localization of the terms, the researcher formed a corpus of documents in Spanish and French, which were taken from the internet. For the description of the terms, the author considered the different types of lexical units in order to establish equivalents between the two languages, both descriptive and defined.

For this elaboration proposal, the work plan of López (2019) was taken as a guide, which sets out the following stages: "Creation of a database, analysis of the extracted corpus, and creation of the glossary" (p. 83). This work plan was selected because of its organization, which seems to be suitable for the present AIED glossary. However, it is important to mention that although the methodology was followed step by step, some adaptations must be made as the researcher's aims are different. Here are the steps to follow for the elaboration of this glossary based on the method followed by López (2019).

Stage 1. Creation and implementation of BICORAIED

Stage 1.1 Creation

For the creation of the database BICORAIED (Bilingual Corpus of AIED), academic search engines such as Google Scholar, ResearchGate, Springer, and the Website of IAED (The International Artificial Intelligence in Education Society) were consulted. The documents that were considered suitable had to meet the following criteria: Title of the document (skimming and scanning were carried out to identify which terms belonged to AIED field), date of publication (the documents had to be up to date and no more than five years old), and type of document (journals, articles, case studies, and University websites).

Stage 1.2. Implementation

The documents obtained from the search were entered into the BICORAIED database, which facilitated the identification of those documents pertaining to the field of AIED. Therefore, the literature should be examined for compliance with the established criteria and carefully

selected in both English and Spanish. In this way, the corpus was analyzed to obtain the terms that can be extracted.

Stage 2. Analysis of the corpus extracted from the BICORAIED

Stage 2.1. Selection

Through AntConc, a computer program that allows corpus analysis for the identification of grammatical patterns, and keywords that are repeated yielding a frequency number greater than three in at least 30 documents, which will indicate which terms are suitable to add to the glossary according to their frequency. In the same way, the program allows for distant reading, to compare lists of words that are not visible to the researcher. AntConc includes different functions: generating concordances, frequency lists of the words in the corpus, collocational patterns and lexical packages, as well as being able to include a reference corpus in order to extract specific vocabulary based on frequencies and to be able to elaborate, for example, a glossary (Sánchez, 2017).

The selected terms will be recorded in terminology cards adapted from the model of López. The terms were listed for easy alphabetical sorting in an Excel sheet and showed the different categories of the terminology card. In addition, the sections were established in lexical units, examples in context, and equivalents in the other language. These cards went through a review process by the advisor of this work in order to give suggestions and corrections if necessary. This is an example of a terminology card.

Table 4

Example of a terminology card adapted from Proposal for a bilingual (Spanish-French) online glossary of architectural terms

TERMINOLOGY CARD		
Lexical unit	Context	Equivalent in the other language

Source: Adapted from López, 2019, p. 85.

Stage 3. Elaboration of a bilingual (English-Spanish) glossary on AIED

Stage 3.1. Verification of the selection of the terms

The database allowed the extraction of terms referring to the field of AI in Education in both languages and an example of the context of use in the target language. The criteria for the selection of terms were the following: suitability of the topic, the terms must fit the field of AIED and number of frequencies. The AntConc program, was useful to determine which terms were appropriate depending on the number of frequencies they presented. To speed up the frequency search process, it was necessary that the corpus was in TXT format, in which case the researcher had to convert the documents of her BICORAIED database, in order to be able to identify the terms efficiently.

Stage 3.2. Application of translation techniques in the search for Spanish equivalents.

At this stage, the same BICORAIED database was used, which contained academic documents in Spanish and was carefully checked to identify the equivalents of the terms. There were also cases in which translation techniques had to be applied such as ***Borrowing***, ***Literal Translation*** and ***Equivalence***. For instance, the term "*Automatic feedback*", the word "*feedback*" is usually used in the educational context, and it does not need a definition because it could be understood, so its equivalent turned out to be *"Feedback automático."* It is worth mentioning that in other cases the word "*retroalimentación*" can also be applied, both terms can be used without altering the meaning. As for the second technique, terms such as "*Black box"* were found where there could be a literal translation without altering the meaning by speaking in the same field. The last technique was used in cases where there was no literal translation in Spanish, therefore a closer equivalence to the meaning had to be sought. Here is a detailed explanation of the techniques mentioned.

> **Borrowing:** Borrowing is where words or expressions are taken directly from the source text and carried over into the target language. This technique is often used when there is no target language equivalent, such as food or clothing, and can help to preserve the cultural context of the source text.

Literal Translation: When using literal translation, each word is translated directly. The target text must be idiomatic and retain the same word order, meaning and style as the source text.

Equivalence: Similar to modulation, this allows you to preserve the meaning of an expression, name or proverb by finding a target language equivalent. (Intertranslation, 2021)

On the other hand, the strategy "Translation using a loan word or loan word plus explanation" is often used when dealing with culture-specific elements, up-to-date concepts and trending words. The loan word is used with an explanation in case it is repeated many times in a text (Baker, 1992, cited in Zohre, 2013). It is worth mentioning that this strategy is like *borrowing*, as some words remained untranslated. This strategy was used in very specific cases, where literal translation could not be applied as it would affect the meaning of the term.

Stage 3.3. Implementation of the selected terms

Once the terms have been selected, a technological tool will be used to create the glossary, Interpreters' Help is compatible with the document containing the list of terms. The format of the glossary will be similar to the index cards, with three columns, each for the following sections: lexical unit, context and finally the equivalent in the other language. In this way, it will be manageable and intelligible to the user.

IV. GLOSSARY OF AIED TERMS

ENGLISH	CONTEXT	SPANISH
Adaptive Group Formation	AI can create groups in students who are suited for particular tasks. This is known as **Adaptive Group Formation**. (Kengam, 2021) *Url:* *http://dx.doi.org/10.13140/RG.2.2.16375.65445*	Grupo de Formación Adaptable
Adaptive learning systems	Artificial intelligence (AI) has been widely applied in educational practices (Artificial Intelligence in Education; AIEd), such as intelligent tutoring systems, teaching robots, learning analytics dashboards, **adaptive learning systems**, human-computer interactions, etc. (Ouyang & Jiao, 2021) *Url:* *https://doi.org/10.1016/j.caeai.2021.100020*	Sistemas de Aprendizaje Adaptativo
Adaptive teaching	LA and algorithm based or human-based recommendations and LA and **adaptive teaching** and learning (AI-based). (Renz, Krishnaraja & Gronau, 2020) *Url:* *https://doi.org/10.3991/ijai.v2i1.12675*	Enseñanza adaptativa
Advanced computing	Although AIEd integrates **advanced computing** and information processing techniques in education, it does not guarantee the good educational outcomes and high quality of learning. (Ouyang & Jiao, 2021)	Informática avanzada

	Url: *https://doi.org/10.1016/j.caeai.2021.100020*	
Affective Computing	Analytical techniques such as ML, EDM, NLP, ANNs, and **affective computing** are commonly adopted for analyzing large-scale data from various educational scenarios. (Chen, Zou, Xie, Cheng & Liu, 2022, p.44) *Url:* *https://scholars.ln.edu.hk/ws/portalfiles/portal/4122 0986/25_1_03.pdf*	Informática afectiva
AI based-solution	Especially algorithm- **or AI-based solutions** have the potential to shape the education market in the long term. (Renz et al., 2020) *Url:* *https://doi.org/10.3991/ijai.v2i1.12675*	Solución basada en la IA
AI ethics	From an analysis of the results, we can see that the scores for awareness of AI ethical issues positively correlated with AI literacy, which shows that a correlation exists between different AI literacies and students' perceptions of **AI ethics**. (Lin, Yu, Shih, & Wu, 2021) *Url:* *https://www.jstor.org/stable/27032867*	Ética de la inteligencia artificial
AI systems	Unlike real teachers, **AI systems** communicate individually with each student and deal with them according to their need and level of understanding. (Ahmad, Rahmat, Mubarik, Alam & Hyder, 2021, p.6) *Url:*	Sistemas de IA

	https://doi.org/10.3390/su132212902	
AI-based systems	But it is often not clear which things in everyday life are supported by algorithm or **AI-based systems** and it is rather difficult for the user to determine when such implementations are present. (Renz et al., 2020) *Url:* *https://doi.org/10.3991/ijai.v2i1.12675*	Sistemas basados en IA
AIED (Artificial Intelligence in Education)	The International Artificial Intelligence in Education society **(AIED)** is an interdisciplinary community at the frontiers of the fields of computer science, education and psychology. (Kengam, 2021) *Url:* *http://dx.doi.org/10.13140/RG.2.2.16375.65445*	Inteligencia Artificial en la Educación
Algorithm	In this training activity, students realized that they had to design a proper **algorithm** so that the car kit could respond correctly. (Lin et al., 2021) *Url:* *https://www.jstor.org/stable/27032867*	Algoritmo
Algorithm Visualizations (Avs)	Studies show that **Algorithm Visualizations (AVs)** are very effective in helping students master the algorithm concepts and skills. (Yan, Lin, & Kinshuk, 2021) *Url:* *https://doi.org/10.1007/s40593-020-00225-z*	Visualización del algoritmo / Visualizaciones del algoritmo
Application Programming Interface	Google makes available the **API (Application Programming Interface)** of its widely used Google Docs program so that third-party companies can create extensions and other products that use or integrate with the software. (Fischer, Pardos, Baker,	Interfaz de Programación de Aplicaciones

	Williams, Smyth, Yu, Slater, Baker & Warschauer, 2020) *Url:* https://doi.org/10.3102%2F0091732X20903304	
Application system	The development function of the educational artificial intelligence **application system** includes five modules: educational needs, educational data, educational features, intelligent models, and educational applications. *Url:* https://doi.org/10.1155/2022/5379646	Sistema de aplicación
Artificial intelligence applications (AIA)	The objective of this study is to explore the role of **artificial intelligence applications (AIA)** in education. (Ahmad et al.,2021) *Url:* https://doi.org/10.3390/su132212902	Aplicaciones de la Inteligencia Artificial
Artificial neural networks (ANNs)	Five topics (i.e., educational data mining (EDM), intelligent tutoring for writing and reading, intelligent tutoring for K12 and special education, **artificial neural networks (ANNs)**. (Chen et al., 2022, p.37) *Url*: https://scholars.ln.edu.hk/ws/portalfiles/portal/41220986/25_1_03.pdf	Redes neuronales artificiales
Artificially-intelligent system	As the greatest proof of AI's human-like thinking and skills, the result of this match shows that a true **artificially-intelligent system** is one that can learn on its own. (Goksel & Bozkurt, 2019)	Sistema de Inteligencia Artificial

	Url:https://doi.org/10.4018/978-1-5225-8431-5.ch014	
Assisted learning	This motivates us to propose the framework of **Assisted Learning** […] (Xian, Wang, Ding, J. & Ghanadan, 2020) *Url*: *https://doi.org/10.48550/arXiv.2004.00566*	Aprendizaje asistido
Augmented reality	Rosetta Stone Language Learning is an **augmented reality** AI empowered app for language learning. (Chen, Xie, & Hwang, 2020) *Url:* *https://doi.org/10.1016/j.caeai.2020.100005*	Realidad aumentada
Automated detection	They are therefore good-candidate machine learning algorithms to be evaluated on the problem of the **automated detection** of reflection in texts. (Ullmann, 2019) *Url:* *https://doi.org/10.1007/s40593-019-00174-2*	Detección automatizada
Automated knowledge acquisition	This is to include **automated knowledge acquisition** that may enhance acquired knowledge in supply chain management in food manufacturing firm context. (Almuiet, & Al-Zawahra, 2019) *Url:* *https://pdfs.semanticscholar.org/2891/bae3828cd1e ea6e2a2564ee00a75060303b0.pdf*	Adquisición automática de conocimiento
Automatic feedback	In STEM courses, as students predominately interact with learning content, **automatic feedback** from the learning system becomes essential. (Yan et al., 2021)	Feedback automático/ Retroalimentación automática

	Url: *https://doi.org/10.1007/s40593-020-00225-z*	
Automatic reasoning	Topics: Real Algebraic Geometry, CAD, Robotics, Computer Algebra and Geometry, **Automatic Reasoning** in Dynamic Geometry, Mathematics Education. (Kovács, Recio & Vélez, 2018) *Url:* *https://www.researchgate.net/publication/326632420*	Razonamiento automático
Automation platform	Through this interface, the **automation platform** operation status information is sent to the education system. (Long & Gao, 2022) *Url:* *https://doi.org/10.1155/2022/5379646*	Plataforma de automatización
Autonomous learning	Other branches of artificial intelligence have designed crucial ingredients towards **autonomous learning**. (Oudeyer, 2017) *Url:* *https://doi.org/10.1017/S0140525X17000243*	Aprendizaje autónomo
Baseline model	As in the **baseline model** M1, the negative regression coefficient for task number in the final model indicates that the probability of solving tasks decreased for later tasks. (Tacoma, Heeren, Jeuring, & Drijvers, 2020) *Url:* *https://doi.org/10.1007/s40593-020-00218-y*	Modelo base de referencia
Behavioral data	By combining **behavioral data** with surveys or psychological scales, researchers can map action sequences to cognitive traits and test whether observed behavioral traces align with theoretical	Datos de comportamiento

	assumptions and refine theories at a granular level. (Fischer et al., 2020) *Url:* *https://doi.org/1fi0.3102/0091732X20903304*	
Big data	Therefore, with the rapid adoption of DL, a human level of accuracy has been reached through neural networks that use **big data** collection. (Goksel & Bozkurt, 2019) *Url:* *https://doi.org/10.4018/978-1-5225-8431-5.ch014*	Macrodatos/Big data
Black box	It is worth noting that we have not reported values of interpretability indexes for the RF algorithm because it generates **black-box** classifiers. (Alonso, 2020) *Url:* *https://doi.org/10.2991/ijcis.d.200715.003*	Caja negra
Blended learning	Besides fully online learning environments, **blended-learning** formats also provide opportunities for students to engage in collaborative learning. (Fischer et al., 2020) *Url:* *https://doi.org/10.3102/0091732X20903304*	Aprendizaje combinado
Bugs	The application should be thoroughly and properly tested to avoid **bugs**. (Kengam, 2021) *Url:* *http://dx.doi.org/10.13140/RG.2.2.16375.65445*	Errores de software/Bugs
CA(Conversational Agents)	**Conversational Agents (CA)**, also known as chatbots, are software packages that can interact with humans using natural language. (Artíles-Rodríguez, Guerra-Santana, Aguiar-Perera &	Agentes conversacionales

	Rodríguez-Pulido, 2021, p.125) *Url:* *https://doi.org/10.12795/pixelbit.86171*	
CAI (Computer Assisted Instruction)	The purpose of this research is to develop **CAI** in the form Android application that can and test its effectiveness. (Hendikawati, Zahid, & Arifudin, 2019). *Url:* *https://doi.org/10.29333/iji.2019.12324a*	Instrucción asistida por computadora
Chatbot	For example, **chatbot** is often described as one of the most advanced and promising AI applications. (Elhajjar, Karam & Borna, 2021). *Url:* *https://doi.org/10.1080/10528008.2020.1835492*	Software conversacional
Classification tree	The accuracy rate is the purpose of reducing the complexity of the **classification tree**. (Dong & Guo, 2021). *Url:* *https://doi.org/10.3233/JIFS-219036*	Árbol de clasificación
Cloud computing	A topic's theme indicates what field of software development it falls into (e.g. web, **cloud computing**, mobile development, etc.). (Yazdanian, West & Dillenbourg, 2020) *Url:* *https://doi.org/10.1007/s40593-020-00231-1*	Computación en la nube
Clustering algorithm	By applying K means **clustering algorithm** the different types of cluster of students can be formed based on the scores. (Sandeep & Vindhya, 2020, p.753) *Url: http://dx.doi.org/10.35940/ijeat.B4089.029320*	Algoritmo de agrupación

Code	Sharples encouraged early- to mid-career researchers to actively contribute to the "development of a **code** of ethical practice in AIED," […] (Holmes, Porayska-Pomsta, Holstein, Sutherland, Baker, Buckingham, Santos, Rodrigo, Cukurova1, Bittencourt & Koedinger, 2022) *Url:* *https://doi.org/10.1007/s40593-021-00239-1*	Código
Cognitive computing	In education, **cognitive computing** refers to reasoning, language processing, machine learning, and human capabilities that help everyday computing solve problems and analyze data. (Oyebola, Olubukola, Wumi, Yaw, Ayokunle, Adesoji, Olawale, Taiwo & Samuel, 2021, p.29) *Url:* *https://publication.babcock.edu.ng/asset/docs/publications/COSC/9712/7017.pdf*	Computación cognitiva
Cognitive robot	For one thing, the author investigated how **cognitive robots** could be used as a companion to develop robot behavior rules acceptable to the human being. (Chen, et al., 2020) *Url:* *https://doi.org/10.1016/j.caeai.2020.100005*	Robot cognitivo
Cognitive Tutor	The ITS **Cognitive Tutor** employed a classifier to detect "gaming-the-system" behavior. (Fang, Lippert, Cai, Chen, Frijters, Greenberg & Graesser, 2021) *Url:*	Tutor cognitivo

	https://doi.org/10.1007/s40593-021-00266-y	
Collaborative learning	In addition, another study considers its features as formal and informal, personalized and situated, social and **collaborative learning** having a focus on content and application. (Ahmad et al., 2021) *Url:* *https://doi.org/10.3390/su132212902*	Aprendizaje colaborativo
Complex problem solving	The critical bottleneck is not whether a task is routine or non-routine, or whether it requires **complex problem solving**. (Tuomi, 2018) *Url:* *https://op.europa.eu/sk/publication-detail/-/publication/5cb8eee3-e888-11e8-b690-01aa75ed71a1*	Resolución de problemas complejos
Computer -based learning environment	A type of **computer-based learning environment** that does have the potential to provide feedback on the student's reasoning in hypothesis testing is the Intelligent Tutoring System (ITS). (Tacoma et al., 2020) *Url:* *https://doi.org/10.1007/s40593-020-00218-y*	Entorno de aprendizaje por computadora
Computer adaptive testing (CAT)	Adaptive assessment or **computer adaptive testing (CAT)** is used to adapts to individual students' abilities by delivering a subsequent question based on their response to previous questions. (Yan et al., 2021). *Url:* *https://doi.org/10.1007/s40593-020-00225-z*	Prueba adaptativa computarizada/ prueba personalizada
Computer program	A **computer program**, on the other hand, can offer personalized tutoring and adapt instruction to the	Programa informático

	individual learner based on the learner's responses to tasks. (Fang et al., 2021) *Url:* https://doi.org/10.1007/s40593-021-00266-y	
Computer science	It is clear that AI is a fast-growing field encompassing the waste boundaries of multidiscipline subjects from mathematics to engineering and from **computer science** to philosophy and linguistics. (Ahmad et al., 2021) *Url:* https://doi.org/10.3390/su132212902	Ciencias de la computación
Computer vision	Furthermore, this approach introduced real-time multichannel user feedback through passive **computer-vision** and active tactile/analog interaction. (de Raffaele, Smith, & Gemikonakli, 2018) *Url:* https://doi.org/10.1145/3172944.3172976	Visión por computadora
Computer-aided design (CAD) software	The famous **CAD software** for children's education is Tinkercad. (Chun, 2021) *Url:* https://doi.org/10.1155/2021/2247346	Software de diseño asistido por computadora (CAD)
Computer-assisted language learning (CALL)	NLP is instrumental for **computer-assisted language learning (CALL)**. (Chen et al., 2022, p.40) *Url:* https://scholars.ln.edu.hk/ws/portalfiles/portal/41220986/25_1_03.pdf	El aprendizaje de la lengua asistido por ordenador o computadora (ALAO)
Computer-Supported	Informed by the degree of collaboration, which is automatically assessed among learners in their	Ambientes Colaborativos de

Collaborative Learning (CSCL)	conversations, instructors can provide feedback to promote learner involvement and collaboration in **CSCL**. (Chen et al., 2022, p.41) *Url:* *https://scholars.ln.edu.hk/ws/portalfiles/portal/4122 0986/25_1_03.pdf*	Aprendizaje Apoyados en Computador
Computerized testing	Compared to **computerized testing** and diagnosis, how AI facilitates subject knowledge acquisition became […] (Chen et al., 2022, pag. 39) *Url*: *https://scholars.ln.edu.hk/ws/portalfiles/portal/4122 0986/25_1_03.pdf*	Pruebas Computarizadas (PC)
Cybernetics	Proceedings of IEEE International Conference on Systems, Man and **Cybernetics**. (Chen et al., 2020) *Url:* *https://doi.org/10.1016/j.caeai.2020.100005*	Cibernética
Dashboard	In the learning analytics field, tools like **dashboard** or visualization of learning data and concepts […] (Yan et al., 2021) *Url:* *https://doi.org/10.1007/s40593-020-00225-z*	Tablero de control
Data visualization	Relatively straightforward **data visualization**, exploration, and modeling techniques can be quite useful, and more advanced methods are not necessary to extract useful information. (Fischer et al., 2020) *Url:* *https://doi.org/10.3102/0091732X20903304*	Visualización de datos
Data-driven	The advantage of the **data-driven approach** is that	Enfoque basado en

approach	the selection of features is not influenced by the decision of the expert. (Ullmann, 2019) *Url:* *https://doi.org/10.1007/s40593-019-00174-2*	datos
Dataset	This **dataset** is obtained through an unofficial Python library that acts as an ad-hoc API8 to Google Trends. (Yazdanian et al., 2020) *Url:* *https://doi.org/10.1007/s40593-020-00231-1*	Conjunto de datos
Decision tree	We have generated a **decision tree** for determining to which cluster a given group would belong based on the action counts as input values. (Hoppe, Doberstein & Hecking, 2021). *Url:* *https://doi.org/10.1007/s40593-020-00229-9*	Árbol de decisión
Decision-making system	The adaptation mechanisms are provided with a **decision-making system** and a machine learning process that collect the information. (Rodríguez-Gracia, Piedra-Fernández, Iribarne, Criado, Ayala, Alonso-Montesinos & de las Mercedes, 2019) *Url:* *http://dx.doi.org/10.3390/su11164320*	Sistema de toma de decisiones
Deep learning (DL)	**Deep Learning (DL)**, a relatively new technology in the realm of ML, involves the complex attempt to unravel human levels of perception and cognition. (Goksel & Bozkurt, 2019) *Url:* *https://doi.org/10.4018/978-1-5225-8431-5.ch014*	Aprendizaje profundo
Deep neural networks	**Deep neural network (DNN)**: It has more than two layers, which allows the complex non-linear	Redes neuronales profundas

	relationship. (Muniasamy & Alasiry, 2020) *Url:* *https://doi.org/10.3991/ijet.v15i01.11435*	
Dialogue systems	AI tools such as student support chatbots (AI driven Personalized Instructional and **Dialogue systems**) […] (Renz et al., 2020) *Url:* *https://doi.org/10.3991/ijai.v2i1.12675*	Sistemas de diálogo
Digital classroom	As a matter of fact, the advent of **digital classroom** may broaden the scale of imparting most up-to-date education. (Singh, 2021) *Url:* *https://doi.org/10.1177/2347631120980272*	Aula digital
Digital visualizations	Specific data values on synapses via rotational interaction and **digital visualizations** as shown in Figure 7b. (de Raffaele et al., 2018) *Url:* *https://doi.org/10.1145/3172944.3172976*	Visualizaciones digitales
Dimension of reflection	The analysis of validity uses the Fischer's exact test to investigate whether the breadth **dimensions of reflection** are independent of the depth dimension of reflection. (Ullmann, 2019) *Url:* *https://doi.org/10.1007/s40593-019-00174-2*	Dimensión reflexiva
Distance learning education	These methods can be used in online learning approach and in distance learning education. (Sandeep & Vindhya, 2020, p. 754) *Url:* *https://doi.org/10.35940/ijeat.B4089.029320*	Educación a distancia

Domain Knowledge model	The key parts of AIED system is **Domain Knowledge** model that provides the capability of the system to complete the tasks that makes the students to judge to contribute towards the solution. (Muniasamy & Alasiry, 2020) *Url:* *https://doi.org/10.3991/ijet.v15i01.11435*	Modelo Conocimiento del Dominio
Dynamic Bayesian Networks (DBNs)	[…] used the **dynamic Bayesian network** models to represent multiple skill hierarchies of students and the relationships. (Ouyang & Jiao, 2021) *Url:* *https://doi.org/10.1016/j.caeai.2021.100020*	Redes Bayesiana Dinámicas
E-Learning (Electronic learning)	**E-learning** is also an open option for webinars and direct interactions with instructors through different chat forums or messages. (Ara, Kumar, Jani, Mitra, García-Tadeo & Devarajan, 2022). *Url:* *https://doi.org/10.1016/j.matpr.2021.09.368*	Aprendizaje electrónico/E-learning
E-learning environment	An artificial neural network is shown in **e-learning environments** to be an important method to forecast student performance. (Yu, 2021) *Url:* *https://doi.org/10.21203/rs.3.rs-739949/v1*	Entorno e-learning
Edit distance	This is followed by light stemming and similarity is found again using **edit distance**. (Oyebola et al., 2021, p. 31) *Url:* *https://publication.babcock.edu.ng/asset/docs/publications/COSC/9712/7017.pdf*	La Distancia de Levenshtein/ Distancia de edición)
Educational data mining (EDM)	Furthermore, there are several sub-fields in educational technology, such as learning analytics	Minería de Datos Educativos.

	and **educational data mining**. (Tuomi, 2018) *Url:* *https://op.europa.eu/sk/publication-detail/-/publication/5cb8eee3-e888-11e8-b690-01aa75ed71a1*	
Educational Process Mining	**Educational process mining** is a new but growing research field. (Piotrkowicz, Wang, Hallam & Dimitrova, 2021) *Url:* *https://doi.org/10.1007/s40593-021-00264-0*	Minería de Procesos en Educación
Educational robot	The **educational robot** can fully mobilize the initiative of student. (Huang, 2021) *Url:* *https://doi.org/10.3991/ijet.v16i05.20311*	Robot educativo
Educational software	In terms of available **educational software** with the integration of AI technologies, much has been designed for mathematics and language learning. (Chen et al., 2020) *Url:* *https://doi.org/10.1016/j.caeai.2020.100005*	Software educativo
Educational Technology (EdTech)	We focus on data-based business models, especially **Educational Technology (EdTech)** companies that innovate the education market with their products and services. (Renz et al., 2020) *Url:* *https://doi.org/10.3991/ijai.v2i1.12675*	Tecnología educativa
Electronic data	Learners who have limited access to the information required to assist them in their studies and the ability to generate and share **electronic data** […] (Renz et al., 2020)	Datos electrónicos

	Url: *https://www.ef.com.mx/assetscdn/WIBIwq6RdJvcD 9bc8RMd/cefcom-epi-site/reports/2021/ef-epi-2021- spanish_latam.pdf*	
Emotional Intelligence (EI)	Although machines create designs, they cannot rival the invention of the human brain. People's intelligence and feelings are endless. They have **emotional intelligence**. (Gokhan, 2021) *Url:* *https://www.researchgate.net/publication/35863457 1_The_Importance_of_Artificial_Intelligence_in_E ducation_A_short_review*	Inteligencia emocional (IE)
Example-based learning	ITSs to facilitate problem-solving and **example- based learning** for scaffolding purposes where computerized testing and diagnosis of learner knowledge and learning processes were frequently concerned. (Chen et al., 2020) *Url:* *https://doi.org/10.1016/j.caeai.2020.100005*	Aprendizaje basado en ejemplo
Expert knowledge model	The **expert knowledge model** is mainly responsible for diagnosing errors in student solutions and is, hence, highly domain-dependent. (Tacoma et al., 2020) *Url:* *https://doi.org/10.1007/s40593-020-00218-y*	Modelo de Conocimiento Experto
Expert system	An **expert system** or pedagogical model manages the introduction of learning materials to the student through an adaptive and interactive user interface. (Tuomi, 2018) *Url:*	Sistema experto

	https://op.europa.eu/sk/publication-detail/-/publication/5cb8eee3-e888-11e8-b690-01aa75ed71a1	
Face recognition	When the network has learned to recognize the faces that have been used for its training, its deep layers become optimized for **face recognition**. (Tuomi, 2018) *Url:* https://op.europa.eu/sk/publication-detail/-/publication/5cb8eee3-e888-11e8-b690-01aa75ed71a1	Reconocimiento facial
Fuzzy logic	At this point we emphasize that **fuzzy logic** allows us to treat imprecision, use approximate reasoning and to define more closely to natural language. (Rodríguez-Gracia et al., 2019) *Url* : http://dx.doi.org/10.3390/su11164320	Lógica difusa
Fuzzy systems	This article provides an overview of different techniques of AI, like expert systems, artificial neural networks, **fuzzy systems** and genetic algorithms. (Alemán, 2017) *Url:* https://www.redalyc.org/articulo.oa?id=193955164005	Sistemas difusos
Game-based learning	They suggest that new teaching approaches, including, **game-based learning**, may provide a solution due to their inclusion of more fun and diverse activities […] (Tatnall, 2021) *Url* : https://doi.org/10.1007/s10639-020-10423-w	Aprendizaje basado en juego

Genetic algorithm	Similar to the **genetic algorithm**, it has operations such as mutation, crossover, and selection. (Long, & Gao, 2022) *Url:* *https://doi.org/10.1155/2022/5379646*	Algoritmo genético
Gesture Reconition Technology	AI helps us understand the mood or ease of student during the lectures by using **Gesture Recognition Technology**. (Kengam, 2021) *Url:* *http://dx.doi.org/10.13140/RG.2.2.16375.65445*	Tecnología de reconocimiento gestual
Hardware device	The system operating procedures need to be readjusted, and some **hardware devices** should be replaced according to the needs. (Long & Gao, 2022) *Url:* *https://doi.org/10.1155/2022/5379646*	Dispositivo de hardware
Hologram	They can see the size of a whale with a **hologram**. (Tuomi, 2018) *Url:* *https://op.europa.eu/sk/publication-detail/-/publication/5cb8eee3-e888-11e8-b690-01aa75ed71a1*	Holograma
Human robot interaction (HRI)	Some researchers argue that empathy and engagement are the two most important factors to be present in the **human–robot interaction**. (Ahmad et al., 2021) *Url:* *https://doi.org/10.3390/su132212902*	Interacción humano-robot (IHR)

Human-computer interactions	The general problem is a lack of continuous communication or synergetic **human-computer interactions**. (Ouyang & Jiao, 2021) *Url:* *https://doi.org/10.1016/j.caeai.2021.100020*	Interacción humano-computadora (IHC)
Hybrid system	The action to be taken together with face-to-face education can enter our lives as a **hybrid system** that combines both education systems by blending face-to-face education with distance (virtual) education. (Gokhan, 2021) *Url:* *https://www.researchgate.net/publication/358634571_The_Importance_of_Artificial_Intelligence_in_Education_A_short_review*	Sistema Híbrido
(ICAIED) International Conference on Artificial Intelligence in Education	Second, considering the close relevance of the **International Conference on Artificial Intelligence in Education (ICAIED)** and IJAIED to our research target. (Chen et al., 2022, p.30) *Url:* *https://scholars.ln.edu.hk/ws/portalfiles/portal/41220986/25_1_03.pdf*	Conferencia internacional sobre la Inteligencia Artificial en la Educación
Immediate feedback	It is critical for the AI systems to offer real-time data analysis and **immediate feedback** to learner […] (Ouyang & Jiao, 2021) *Url:* *https://doi.org/10.1016/j.caeai.2021.100020*	Retroalimentación inmediata
Information comunication tecnology (ICT)	The twofold goal of this study was to test the merits of the model in general, and for **ICT** integration in education in particular. (Tatnall, 2021) *Url:*	Tecnologías de la Información y Comunicación (TIC)

	https://doi.org/10.1007/s10639-020-10423-w	
Information processing	This is a qualitatively new development in the history of computing and **information processing**. (Tuomi, 2018) *Url:* *https://op.europa.eu/sk/publication-detail/-/publication/5cb8eee3-e888-11e8-b690-01aa75ed71a1*	Procesamiento de información
Information-processing theory	AI embraces the construction of the **information-processing theory** of intelligence. (Goksel & Bozkurt, 2019) *Url:* *https://doi.org/10.4018/978-1-5225-8431-5.ch014*	Teoría del procesamiento de la información
Instructional design	The use of technology should be tightly connected with educational and learning theory to inform **instructional design** and technological development. (Ouyang & Jiao, 2021) *Url:* *https://doi.org/10.1016/j.caeai.2021.100020*	Diseño instruccional
Integrative specialized learning application (ISLA)	In **ISLA**, a virtual agent named Jessie adjusts an autistic learner's emotional state in real-time and provides personalized encouragement and support to assist problem-solving during learning. (Chen et al., 2022, p. 40) *Url:* *https://scholars.ln.edu.hk/ws/portalfiles/portal/41220986/25_1_03.pdf*	Aplicación integradora de aprendizaje especializado
Intelligent agent	Individually, **intelligent agent** is utilized for the exchange of bargaining offers […] (Almuiet, & Al-Zawahra, 2019)	Agente inteligente

	Url: *https://pdfs.semanticscholar.org/2891/bae3828cd1e ea6e2a2564ee00a75060303b0.pdf*	
Intelligent educational system	This peculiar domain provides a number of unique challenges with respect to the adoption of effective and **intelligent educational systems** to help students overcome their "concrete operational phase" when learning new concepts. (de Raffaele et al., 2018) *Url:* *https://doi.org/10.1145/3172944.3172976*	Sistema educativo inteligente
Intelligent learning environment	An artificial intelligence model is centered on the learner creates an **intelligent learning environment**. (Machii, 2021) *Url:* *https://www.researchgate.net/publication/35581983 5*	Entorno de aprendizaje inteligente
Intelligent machine system	This intelligence is intended to enable the development of **intelligent machine systems** that are much beyond the limits of human labour. (Ara et al., 2022) *Url:* *https://doi.org/10.1016/j.matpr.2021.09.368*	Sistema de máquina inteligente
Intelligent Personal Assistants (IPAs)	Voice recognition, voice analysis, and language processing can be regarded as the common features of **Intelligent Personal Assistants (IPAs).** (Goksel & Bozkurt, 2019) *Url:* *https://doi.org/10.4018/978-1-5225-8431-5.ch014*	Asistente personal inteligente

Intelligent system	An **intelligent system** that interacts presents information and provides a test of a student's knowledge is known as an intelligent tutoring system (ITS). (Ahmad et al., 2021) *Url:* https://doi.org/10.3390/su132212902	Sistema inteligente
Intelligent Tutoring Systems (ITS)	Decomposition algorithm to provide students working on programming assignments in an **intelligent tutoring system** with hints on their next steps. (Fischer et al., 2020) *Url:* https://doi.org/10.3102/0091732X20903304	Sistema de tutoría inteligente
Interactive simulation	Many of these systems provide excellent explanations of the logic of hypothesis testing, often illustrated with **interactive simulations**. (Tacoma et al., 2020) *Url:* https://doi.org/10.1007/s40593-020-00218-y	Simulación interactiva
Internal consistency	The ITS keeps an eye on the **internal consistency** of the student's solution so far. (Tacoma et al., 2020) *Url:* https://doi.org/10.1007/s40593-020-00218-y	Consistencia interna
Item Response Theory (IRT)	Predictive modelling uses algorithms like **Item Response Theory (IRT)**. (Yan et al., 2021) *Url:* https://doi.org/10.1007/s40593-020-00225-z	Teoría de Respuesta al Ítem (TRI)
Knowledge engineering	Then, information is translated into knowledge thanks to tools provided by **knowledge engineering**. (Alonso, 2020)	Ingeniería del Conocimiento

	Url: https://doi.org/10.2991/ijcis.d.200715.003	
Knowledge-based systems	Also noted that **knowledge-based systems** are systems that store human knowledge, so that users can interact with them in order to solve problems in specific fields. (Agbo & Agbo, 2020) *Url:* http://dx.doi.org/10.19101/TIPCV.2020.618044	Sistemas Basados en el Conocimiento
Knowledge tracing	Streeter's work generalizes **knowledge tracing** and offers an elegant probabilistic model for modeling learning curves. (Rahman, 2022) *Url:* http://www.ijtsrd.com/papers/ijtsrd49783.pdf	Rastreo de conocimiento
Language processing	Voice recognition, voice analysis, and **language processing** can be regarded as the common features of Intelligent Personal Assistants (IPAs). (Goksel & Bozkurt, 2019) *Url:* https://doi.org/10.4018/978-1-5225-8431-5.ch014	Procesamiento de lenguaje
Learning analytics	By following these recommended design strategies, a computer science course is used as an example to show our initial practices of including **learning analytics** in the course learning design loop. (Yan et al., 2021) *Url:* https://doi.org/10.1007/s40593-020-00225-z	Analítica de aprendizaje
Learning analytics dashboard	Artificial intelligence (AI) has been widely applied in educational practices (Artificial Intelligence in Education; AIEd), such as intelligent tutoring	Panel de análisis de aprendizaje

	systems, teaching robots, **learning analytics dashboards**, adaptive learning systems, human-computer interactions, etc. (Ouyang & Jiao, 2021) *Url:* *https://doi.org/10.1016/j.caeai.2021.100020*	
Learning design	In online education, **learning design** is a process of designing students' learning experience through a set of pedagogically informed learning activities that make effective use of appropriate resources, technologies, and support. (Yan et al., 2021) *Url:* *https://doi.org/10.1007/s40593-020-00225-z*	Diseño de aprendizaje
Learning Design-Analytic (LDA) model	A model of learning design interacting with learning analytics is proposed in this study, called **Learning Design-Analytic (LDA) model**. (Yan et al., 2021) *Url:* *https://doi.org/10.1007/s40593-020-00225-z*	Modelo de diseño analítico de aprendizaje
Learning gaps	In SPOL, students' self-awareness of knowledge state and **learning gaps** can help them to reflect on learning and seek for help. (Yan et al., 2021) *Url:* *https://doi.org/10.1007/s40593-020-00225-z*	Brechas de aprendizaje
Learning Management System LMS	The **LMS** provides an integrated and digital platform to key stakeholders particularly to the teachers and students for sharing course outlines and other materials. (Tatnall, 2021) *Url:* *https://doi.org/10.1007/s10639-020-10423-w*	Sistema de gestión de aprendizaje
Learning	[…] which was integrated in the **learning platform**	Plataforma de

platform	to enable real-time collaboration. (Hoppe et al., 2021) *Url:* *https://doi.org/10.1007/s40593-020-00229-9*	aprendizaje
Learning programme	The **learning programme** for this artificial intelligence and machine learning system is a customised learning system that improves the learning experience of students more deeply and pleasantly. (Ara et al., 2022) *Url:* *https://doi.org/10.1016/j.matpr.2021.09.368*	Programa de aprendizaje
Linear function	LR aims at modeling the posterior probabilities of the two classes via **linear functions**. (Cruz-Jesus, Castelli, Oliveira, Mendes, Nunes, Sa-Velho & Rosa-Louro, 2020). *Url: https://doi.org/10.1016/j.heliyon.2020.e04081*	Función lineal
Linear regression	A simple **linear regression** was used to investigate the relation between machine learning performance and the rater performance. (Ullmann, 2019) *Url:* *https://doi.org/10.1007/s40593-019-00174-2*	Regresión lineal
Machine Learning (ML)	Furthermore, artificial intelligence and **machine learning (ML)** intelligence can identify which ideas are likely to be misunderstood by pupils. (Ara et al., 2022) *Url:* *https://doi.org/10.1016/j.matpr.2021.09.368*	Aprendizaje automático (ML)
Machine learning algorithms	They will either use features ranking algorithms or look at the selected features while training the	Algoritmos de aprendizaje

	dataset on different **machine learning algorithms**. (Rahman, 2022) *Url:* http://www.ijtsrd.com/papers/ijtsrd49783.pdf	automático
Manual coding	Such traditional analysis of the full contents of a publication through **manual coding** and synthesis [...] (Chen et al., 2022, p. 29) *Url:* https://scholars.ln.edu.hk/ws/portalfiles/portal/4122 0986/25_1_03.pdf	Codificación manual
Massive Open Online Courses (MOOCs)	Udemy, a **Massive Open Online Courses (MOOCs)** platform where anyone can create and share a free or paid MOOC. (Yazdanian et al., 2020) *Url:* https://doi.org/10.1007/s40593-020-00231-1	Cursos en línea masivos y abiertos (MOOCs)
Mechanical learning	Secondly, we should test, and retest AI featured educational processes to avert automated processes and **mechanical learning**. (Goksel & Bozkurt, 2019) U*rl:* https://doi.org/10.4018/978-1-5225-8431-5.ch014	
Meta-analyses	Understanding new areas that offer fresh perspectives into **meta-analyses** that produces energetic methods of learning. (Ara et al., 2022) *Url:* https://doi.org/10.1016/j.matpr.2021.09.368	Meta-análisis
Metacognitive Tutor	This paper demonstrates how the POALS **Metacognitive Tutor** can be used as input for a learning analytics dashboard by constructing.	Tutor metacognitivo

	(Kristine, Carlon, & Cross, 2021) *Url:* *https://icce2021.apsce.net/wp-content/uploads/2021/12/ICCE2021-Vol.I-PP.-267-272.pdf*	
Metadata	The learning of a clinical skills is recorded through an entry in the Clinical Skill Passport app along with various **metadata**. (Piotrkowicz et al., 2021) *Url:* *https://doi.org/10.1007/s40593-021-00264-0*	Metadatos
Microservice	This **microservice** selects the transformation rules from the repository (RRM) that must be executed to accomplish the set of adaptation operations (AEOpMi). (Rodríguez-Gracia et al., 2019) *Url:* *http://dx.doi.org/10.3390/su11164320*	Microservicio
Mobile learning	Second, several educational strategies, such as project-based learning, collaborative learning, blended learning, problem-based learning, and **mobile learning** […] (Chen et al., 2020) *Url:* *https://doi.org/10.1016/j.caeai.2020.100005*	Aprendizaje móvil
Model -tracing tutor	A **model-tracing tutor**, on the other hand, would contain a rule for adding hypotheses as well as a rule for calculating the value of the test statistic. (Tacoma et al., 2020) *Url:* *https://doi.org/10.1007/s40593-020-00218-y*	Modelo de acompañamiento tutorial/ Modelo de Tutor rastreo de ejemplo
Modern	In short, like every other sector, education is also	Tecnología moderna

technology	influenced by **modern technology** and AI is one of the types. (Ahmad et al., 2021) *Url:* https://doi.org/10.3390/su132212902	
Multiple-choice questions (MCQ)	To overcome part of these challenges researchers developed automated **multiple-choice questions (MCQ)** where students provide answers using a computer keyboard. (Oyebola et al., 2021, p. 30) *Url:* https://publication.babcock.edu.ng/asset/docs/publications/COSC/9712/7017.pdf	Preguntas de opción múltiple
Natural Language Generation (NLG)	This **NLG** pipeline is recognized as the most popular in the related literature. (Alonso, 2020) *Url:* https://doi.org/10.2991/ijcis.d.200715.003	Generación de lenguaje natural
Natural language processing (NLP)	In addition, **Natural Language Processing (NLP)** and one of its best examples, intelligent personal assistants, is discussed in detail. (Goksel & Bozkurt, 2019) U*rl:* https://doi.org/10.4018/978-1-5225-8431-5.ch014	Procesamiento del Lenguaje Natural (PLN)
Network analysis	Besides, SNAPP browser plugin tools are dedicated to **network analysis** of the interaction between forums. (Machii, 2021) *Url:* https://www.researchgate.net/publication/355819835	Análisis de redes
Node	The grey (middle) leaf **node** is dominated by cluster 2 but also contains a considerable share also	Nodo

	of cluster 3 elements. (Hoppe et al., 2021) *Url:* *https://doi.org/10.1007/s40593-020-00229-9*	
Online community	Such data can also give information on relationships and networks within an **online community**. (Fischer et al., 2020) *Url:* *https://doi.org/10.3102/0091732X20903304*	Comunidad virtual
Online learning	It is referred to as virtual or **online learning** in other contexts. (Ara et al., 2022) *Url:* *https://doi.org/10.1016/j.matpr.2021.09.368*	Aprendizaje en línea
Optical Character Recognition (OCR)	Most of **OCR** algorithms segment words into isolated characters which are recognized individually. (AlSaid, Alkhatib, Aloraidh, Alhaidar & Bashar, 2019) *Url:* *http://dx.doi.org/10.1109/ICTCS.2019.8923044*	Reconocimiento Óptico de caracteres (OCR)
Pattern recognition	The hypothesis-driven approach performs **pattern recognition** with predefined sequential of interactions with lecture materials, videos and assignments on the given action logs. (Hoppe et al., 2021) *Url:* *https://doi.org/10.1007/s40593-020-00229-9*	Reconocimiento de patrones
Peer Help System module (PHelpS)	As such, Jim's extensive work on supporting lifelong learning has paved our way, in particular when it comes to the fact that a peer-help system such as **PHelpS** or iHelp. (Yazdanian et al., 2020) *Url:*	Módulo de sistema de ayuda entre iguales

	https://doi.org/10.1007/s40593-020-00231-1	
Personalized instruction	ITSs' effectiveness for teaching autistic students owes much to their ability to provide immediate and **personalized instruction** and feedback, which is as effective as one-to-one tutoring. (Chen et al., 2022, p. 40) *Url:* *https://scholars.ln.edu.hk/ws/portalfiles/portal/41220986/25_1_03.pdf*	Instrucción personalizada
Personalized learning	We argue that the future development of the AIEd field must lead to the iterative development of the learner-centered, data-driven, **personalized learning** in the current knowledge age. (Ouyang & Jiao, 2021) *Url:* *https://doi.org/10.1016/j.caeai.2021.100020*	Aprendizaje personalizado
Personalized teaching	AIED enables **personalized teaching** by providing students with a better learning experience. (Gokhan, 2021) *Url:* *https://www.researchgate.net/publication/358634571_The_Importance_of_Artificial_Intelligence_in_Education_A_short_review*	Enseñanza personalizada
Predictive analytics	The paper concludes that the use of artificial intelligence and **predictive analytics** will enhance blended learning by providing educators with useful information and learners with flexibility. (Machii, 2021) *Url:* *https://www.researchgate.net/publication/35581983*	Analítica predictiva

	5	
Predictive modelling	Of these approaches, **predictive modelling** is used to estimate students' knowledge proficiency through computerized assessment, including auto-graded self-assessment. (Yan et al., 2021) *Url:* *https://doi.org/10.1007/s40593-020-00225-z*	Modelización predictiva
Problem based-learning	This can range from fully embedded practice throughout the whole curriculum, to short-term industrial experience in the form of placements and internships, to **problem-based learning** drawing on realistic situations. (Piotrkowicz et al., 2021) *Url:* *https://doi.org/10.1007/s40593-021-00264-0*	Aprendizaje Basado en Problemas (ABP)
Programming language	These are tools that fulfill a specific purpose but not generally as a **programming language** or framework, and are small in scope. (Yazdanian et al., 2020) *Url:* *https://doi.org/10.1007/s40593-020-00231-1*	Lenguaje de programación
Reinforcement Learning	AI techniques such as **reinforcement learning** can also be utilized to empower edtech. (Chaudhry & Kazim, 2021) *Url:* *https://doi.org/10.1007/s43681-021-00074-z*	Aprendizaje de refuerzo
Robot assisted teaching	Among them, the research of intelligent educational **robot assisted teaching** is less popular due to the limitation of technical level, which is a less studied field in the field of English teaching. (Huang, 2021) *Url:*	Enseñanza asistida por robot

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	https://doi.org/10.3991/ijet.v16i05.20311	
Robot behavior	For one thing, the author investigated how cognitive robots could be used as a companion to develop **robot behavior** rules acceptable to the human being. (Chen et al., 2020) *Url: https://doi.org/10.1016/j.caeai.2020.100005*	Comportamiento del robot
Robot control	The advancement of emerging computer technologies such as **robot control** [...] (Gokhan, 2021) *Url:* *https://www.researchgate.net/publication/35863457 1_The_Importance_of_Artificial_Intelligence_in_E ducation_A_short_review*	Control de robot
Robot operating system	Among them, the NAO educational robot system is a **robot operating system** developed based on the NAO robot platform, mainly including speech processing, body movements, network communication and other functions. (Huang, 2021) *Url: https://doi.org/10.3991/ijet.v16i05.20311*	Sistema operativo robótico
Self-directed learning	Blended learning, which combined collaborative and **self-directed learning**, was included in the integrated framework. (Machii, 2021) *Url:* *https://www.researchgate.net/publication/35581983 5*	Aprendizaje autodirigido
Self-regulated learning (SRL)	Text analytics enable the processing of student reflections and linking to **SRL** processes. (Piotrkowicz et al., 2021) *Url:* *https://doi.org/10.1007/s40593-021-00264-0*	Aprendizaje autorregulado

Sequence alignment	**Sequence alignment** provides a similarity measure between pairs of action logs originating from the group work. (Hoppe et al., 2021) *Url:* https://doi.org/10.1007/s40593-020-00229-9	Alineamiento de secuencias
Server	The **server** communicates with NAO robot through the interface. (Huang, 2021) *Url:* https://doi.org/10.3991/ijet.v16i05.20311	Servidor
Simulator online	Applications such as TensorFlow allow students to interact with **simulators online** to allow customization of neural network architectures and visualize the obtained result. (de Raffaele et al., 2018) *Url:* https://doi.org/10.1145/3172944.3172976	Simulador en línea
SIS (Student Information System)	**Student information systems (SIS)** have been widely adopted to store and organize student profile information (e.g., demographics, academic background) and academic records (e.g., course enrollment and final grades) in schools. (Fischer et al., 2020) *Url:* https://doi.org/10.3102/0091732X20903304	Sistemas de Información Estudiantil (SIS)
Smart data mining algorithm (SDMA)	A **smart data mining algorithm (SDMA)** is utilized to identify and sum up the educational data and enhance teaching information consistency to enhancethe efficiency of the educational system. (Yu, 2021) *Url:*	Algorítmo inteligente de minería de datos

	https://doi.org/10.21203/rs.3.rs-739949/v1	
Smart device	The disparity between the developed and developing world in terms of access to the internet and **smart device** was immediately recognised as a 'Digital Divide'. (Duggan, 2020) *Url:* *https://iite.unesco.org/wp-content/uploads/2020/11/Steven_Duggan_AI-in-Education_2020.pdf*	Dispositivo inteligente
Smart learning (SL)	**Smart learning (SL)** is linked with the development of smart devices based on intelligent technologies. *Url:* *https://doi.org/10.3390/su132212902*	Aprendizaje inteligente
Social network site (SNS)	Their findings suggest that, in fact, **SNS** may yield a negative effect on AA, but it is minimal, especially in the case of Facebook. (Cruz-Jesus et al., 2020) *Url: https://doi.org/10.1016/j.heliyon.2020.e04081*	Sitio de redes sociales (SNS)
Social robots	Like other intelligent systems, **social robots** are also intelligent machines following social behavior and interacting with humans one way or another. (Ahmad et al., 2021) *Url:* *https://doi.org/10.3390/su132212902*	Robot social
Sound signal	First, the user inputs the corresponding **sound signal**. (Huang, 2021) *Url:* *https://doi.org/10.3991/ijet.v16i05.20311*	Señal sonora
Speech recognition	Speech processing includes **speech recognition** and speech synthesis functions. (Huang, 2021)	Reconocimiento de voz

	Url:	
	https://doi.org/10.3991/ijet.v16i05.20311	
STEM (science, technology, engineering, and mathematics)	Combined data analyses and continuous exchange of speakers and graduate student researchers to explore and improve instructional practices and outcomes in foundational **STEM (science, technology, engineering, and mathematics)** courses reaching hundreds of thousands of students. (Fischer et al., 2020) *Url:* https://doi.org/10.3102/0091732X20903304	CTIM (Ciencias, Tecnología, Ingeniería y Matemáticas)
Structural topic modeling (STM)	The **STM** results respond to RQ4, revealing frequently occurring issues throughout the review period. (Chen et al., 2022) *Url:* https://scholars.ln.edu.hk/ws/portalfiles/portal/41220986/25_1_03.pdf	Modelo de tema estructural
Student model	Problems are selected to fill gaps between the **student model** and the domain model. (Fang et al., 2021) *Url:* https://doi.org/10.1007/s40593-021-00266-y	Modelo de estudiante
Supervised learning	Technically, **supervised learning** creates machines that map input patterns into a collection of output classes. (Tuomi, 2018) *Url:* https://op.europa.eu/sk/publication-detail/-/publication/5cb8eee3-e888-11e8-b690-01aa75ed71a1	Aprendizaje supervisado
Support vector	This paper discusses design methods based on	Máquinas de vector

machine (SVM)	automation ideas and proposes an artificial intelligence education system based on differential evolution (DE) algorithm optimization **support vector machine (SVM)**. (Long & Gao, 2022) *Url:* *https://doi.org/10.1155/2022/5379646*	de soporte
Tactile sensor	The Tega system is equipped with a visual sensor and an acoustic sensor to capture the video and voice streams of the child, along with a **tactile sensor** to capture the interactions between the child and the virtual game environment over the tablet screen. (Yang & Zhang, 2019) *Url:* *https://www.researchgate.net/publication/333231642_Artificial_Intelligence_in_Intelligent_Tutoring_Robots_A_Systematic_Review_and_Design_Guidelines*	Sensor táctil
Target answer	The example in Figure 3 illustrates the rating task with a partial example from the data used in this paper:4 Given a question (Q) and a correct **target answer (TA)**. (Bertram, Weiss, Zachrich & Ziai, 2021). *Url:* *https://doi.org/10.1016/j.caeai.2021.100038*	Respuesta objetivo
Teaching robot	For example, as conversational robots and learning companions are becoming more and more available, learning by **teaching robots** shows some potential. (Tuomi, 2018) *Url:* *https://op.europa.eu/sk/publication-detail/-*	Robot pedagógico

	/publication/5cb8eee3-e888-11e8-b690-01aa75ed71a1	
Technology-enhanced learning	The higher AIEd research productivity in these countries/regions can be partially attributed to their governments' efforts to promote **technology-enhanced learning** through educational policy and funding. (Chen et al., 2022) *Url:* *https://scholars.ln.edu.hk/ws/portalfiles/portal/41220986/25_1_03.pdf*	Aprendizaje mejorado con tecnología
Text analytics	**Text analytics** of very short documents, as the WBA reflections in our case, is challenging […] (Piotrkowicz et al., 2021) *Url:* *https://doi.org/10.1007/s40593-021-00264-0*	Análisis de textos
Threshold	However, some groups exceeded this **threshold** by several hundreds of words so that the word count can still be seen as a measure of engagement and group productivity. (Hoppe et al., 2021) *Url:* *https://doi.org/10.1007/s40593-020-00229-9*	Umbral
Time management	Such as learning orientations and group composition, and an intermediate layer of **time management** that is related to organizing the assignment. (Tatnall, 2021) *Url:* *https://doi.org/10.1007/s10639-020-10423-w*	Gestión de tiempo
Training activity	In the **training activity** in week three, students were separated into groups, and each group was	Actividad formativa

	provided with a motor-controlled car kit, as shown in Figure 1. (Lin et al., 2021) *Url:* https://www.jstor.org/stable/27032867	
Training data	Models sometimes inadvertently store **training data** with sensitive information that is revealed through model analysis. (Chen et al., 2022) *Url:* https://scholars.ln.edu.hk/ws/portalfiles/portal/41220986/25_1_03.pdf	Datos de entrenamiento
Training Need Analysis (TNA)	The process of finding the skills that a workforce needs to learn is known as **Training Needs Analysis** (TNA for short). (Yazdanian et al., 2020) *Url:* https://doi.org/10.1007/s40593-020-00231-1	Análisis de necesidades de capacitación
Turing Test method	The **Turing Test method** has shown that AI and machine learning are capable of acting in the same way that people do. (Ara et al., 2022) *Url:* https://doi.org/10.1016/j.matpr.2021.09.368	Método Prueba de Turing
Tutoring systems (TS)	This study is focused on the AI applications: **tutoring systems (TS)**, social robots (SR), and smart learning (SL) and their[…] (Ahmad et al., 2021) *Url:* https://doi.org/10.3390/su132212902	Sistemas de tutorías
Ultrasonic sensor	The purpose of **ultrasonic sensors** is to measure the distance using ultrasonic waves. (AlSaid et al., 2019).	Sensor ultrasónico

	Url: *http://dx.doi.org/10.1109/ICTCS.2019.8923044*	
Unigrams	The choice made about features was to only use textual features in form of **unigrams** represented as a set of binary values. (Ullmann, 2019) *Url:* *https://doi.org/10.1007/s40593-019-00174-2*	Unigrama
User interface	The Little Dragon creates smart applications that analyze the user's facial expressions or gestures and adapt the **user interface** accordingly. (Kengam, 2021) *Url:* *http://dx.doi.org/10.13140/RG.2.2.16375.65445*	Interfaz de usuario (IU)
Virtual agent	A **virtual agent** named Jessie adjusts an autistic learner's emotional state in real-time and provides personalized encouragement and support to assist problem-solving during learning. (Chen et al., 2022, p. 40) *Url:* *https://scholars.ln.edu.hk/ws/portalfiles/portal/4122 0986/25_1_03.pdf*	Agentes virtuales
Virtual assistants	**Virtual assistants** used on phones have provided speedier access to the desired information with voice commands. (Gokhan, 2021) *Url:* *https://www.researchgate.net/publication/35863457 1_The_Importance_of_Artificial_Intelligence_in_E ducation_A_short_review*	Asistentes virtuales
Virtual Learning	In formal higher education, **virtual learning**	Entorno virtual de

Environment (VLE)	environments (VLE) are widely used for course delivery. (Yan et al., 2021) *Url:* *https://doi.org/10.1007/s40593-020-00225-z*	aprendizaje
Virtual learning platform	The use of **virtual learning platforms** is one of the most fundamental methods of delivering learning resources to online and traditional mode. (Machii, 2021) *Url:* *https://www.researchgate.net/publication/35581983 5*	Plataforma virtual de enseñanza
Virtual reality	**Virtual reality** is used for lessons that pose a risk and are not easily accessible. (Gokhan, 2021) *Url:* *https://www.researchgate.net/publication/35863457 1_The_Importance_of_Artificial_Intelligence_in_E ducation_A_short_review*	Realidad virtual
Visual perception	The theory governing the development of computer systems that are able to perform tasks which normally require human intelligence, such as **visual perception** […] (Goksel & Bozkurt, 2019) *Url:* *https://doi.org/10.4018/978-1-5225-8431-5.ch014*	Percepción visual
Voice Assistant	With the recent boost in Artificial Intelligence and Speech Recognition technologies, the **Voice Assistant**, also known as the Intelligent Personal Assistant. (Goksel & Bozkurt, 2019) *Url:* *https://doi.org/10.4018/978-1-5225-8431-5.ch014*	Asistente de voz
Voice recognition	**Voice recognition**, voice analysis, and language	Reconocimiento de

	processing can be regarded as the common features of Intelligent Personal Assistants (IPAs). (Goksel & Bozkurt, 2019) *Url:* *https://doi.org/10.4018/978-1-5225-8431-5.ch014*	voz
Web mining	Keywords: **Web mining**, MOOCs, Stack overflow, Job advertisements, Training needs analysis. (Yazdanian et al., 2020) *Url:* *https://doi.org/10.1007/s40593-020-00231-1*	Minería Web
Work-based Learning	**Work-based learning** is especially prominent in professional education programmes […] (Piotrkowicz et al., 2021) *Url:* *https://doi.org/10.1007/s40593-021-00264-0*	Aprendizaje Basado en el Trabajo
Workplace-based assessment (WBA)	Finally, we used text analytics to look into the reflections that students leave on **WBA** and compare the content between year groups and placement setting. (Piotrkowicz et al., 2021) *Url:* *https://doi.org/10.1007/s40593-021-00264-0*	Evaluación basada en el trabajo
Explainable Artificial Intelligence (XAI)	**Explainable AI (XAI)** is expected to endow intelligent systems with fairness, accountability, transparency and explanation ability when interacting with humans. (Alonso, 2020) *Url:* *https://doi.org/10.2991/ijcis.d.200715.003*	Inteligencia Artificial Explicable

V. ANALYSIS AND CONCLUSIONS

Before preparing this monographic work, the researcher stopped to analyze which modality would be the most appropriate for obtaining a degree. Therefore, he reviewed in detail each of the modalities that the Universidad Autónoma del Estado de Quintana Roo offers and thus decided that a monograph is an excellent option. Since this is documentary research that seeks to contribute to the educational environment, it was necessary to carry out an exhaustive investigation of academic documents that were suitable for the preparation of this glossary.

With this work, it is hoped that users and the main audience such as students and teachers who are interested in the field of artificial intelligence in education will find it useful and also use it as a reference tool. Translators and researchers could also benefit from it in their translation work or academic research related to the selected field. It is important to mention that this glossary was elaborated under the main guidance of the adviser José Luis Borges Ucán, together with the supervision and cooperation of other professors belonging to the Universidad Autónoma del Estado de Quintana Roo.

This last section shares the problems faced by the researcher during the elaboration of the monographic work and how they were solved. The selection of the topic was the first problem, as it implied a search for current and unpublished topics. Various topics from different areas were explored, but they were very complex, and did not meet the requirements. The main supervisor of this work was of great help, since thanks to his experience and advice, it was possible to explore topics of interest to the researcher and, above all, some that were suitable for development. It was concluded that the topic determined would be Artificial Intelligence in Education and, with the necessary adjustments, it was decided that the title would be "Elaboration of an English-Spanish glossary of terms related to Artificial Intelligence in Education".

All researchers should be aware of the benefits that their work can bring to society and, linked to this, direct their research to a certain group that may be interested in the subject. From the researcher's point of view, the writing of the justification was a challenge, as she seemed to know the type of audience that might be interested in this glossary, however, with the help of the consultant, she redirected it to a specific group and stated the objectives in a clear and precise way for a better understanding of the reader. For this reason, future researchers are encouraged to be open to suggestions and to present their progress to more knowledgeable authors who are able to identify errors in the wording, so that the audience understands the author's message. During the literature review, the researcher noticed that there is no variety of glossaries on artificial intelligence. The limited number of findings were glossaries on websites which benefited this research. This confirms that there are not many AI glossaries, reducing the likelihood that another author has compiled AI terms within the area of education.

Glossaries obtained from the internet were consulted, such as *"AI Glossary"*, an issue resulting from a cooperation of the Sino-German Company Working Group on Industrie 4.0 and Intelligent Manufacturing (AGU) Expert Group Artificial Intelligence, which was elaborated in 2020 and is a recent glossary. Furthermore, it can be noted that the compiled terms were the result of a not-so-exhaustive search, as only a list of 84 AI terms focused on the area of the manufacturing industry is presented. It is worth mentioning that the target groups of this glossary are employees and manufacturing companies that might face technical problems when using production equipment, so the glossary is expected to improve their working environment and facilitate the understanding of AI terms.

The other recent issue that caught the researcher's attention was *"A preliminary glossary of artificial intelligence in radiology"*, produced by Pakdemirli in 2019. As the title denotes, it is a glossary with a compilation of terms used in the area of medicine, particularly radiology. As AI has been developing into a common language, the author seeks to benefit radiology practitioners by offering a reference tool that even experienced radiologists can use. Like the other glossary, the format he uses to present his terms is too simple, nor was an exhaustive search carried out. Both examples of glossaries are mentioned, as it was difficult to find glossaries focused on the field of AI, while the ones already referenced were the only ones that were relevant and obtained from the internet. The researcher also visited the library of the Universidad Autónoma de Estado

de Quintana Roo and found two glossaries that were of interest to her: *Spanish-English-Maya-Latin Glossary of the most used medicinal herbs of the Mayan world* and *Spanish-English Glossary of the names for some typical dishes from the Yucatán Peninsula*. Both glossaries produced in the same year by English Language students did not include a literature review section and the methodology used was not detailed, which was not very helpful to the researcher.

Making a glossary requires effort, perseverance, and patience; it is not so easy to elaborate, as the researcher must do extensive reading to learn about the topic to be developed. Although she liked the topic, she was not familiar with it and had to read many websites, as well as research articles and news on social media that were associated with AIED. Her personal learning environment was subscribing to different platforms such as ResearchGate, Mendeley, and even the use of social networks such as Twitter were contributory to the compilation of terms, as in this way the researcher could keep up to date with AIED research articles. As a suggestion, if the researcher decides to read articles from these sites, they should follow authors whose interests are in the same field and the article recommendations will come automatically, thus facilitating the author's search. Besides, one can say that it is necessary to know how to select the documents to obtain the required information, it is recommended to use reliable academic search engines and academic databases, review the authors' previous research works, read abstracts and the keywords, analyze the topic to see if it related to the field, and if the document is very recent it may enrich the research topic.

From a personal experience, it can be said that while writing the relevant sections of the glossary, a database was formed to extract the corpus and identify keywords that could be added to the glossary. This part was complicated and tedious, as one had to be careful with the selection. As the researcher had some knowledge about some concepts, she was able to make an association when reading as many terms were identified that were repeated in at least five different documents. The extensive search resulted in a compilation of 200 terms from the area of AIED, which underwent several corrections until they were finally approved by the main consultant.

However, the documents were converted from PDF to TXT format in order to speed up the AntConc program, since its main function is to analyze linguistic corpora. This tool saves the translator the time of searching the document separately by simply entering keywords, which

allowed the researcher to obtain the frequency of each term and thus verify whether it met the selection criteria. Another problem that was noticed during the selection was the translation or search for the Spanish equivalents. In some cases, the concepts can be translated without any problem, however, there are exceptions that can cause confusion about the meaning of the term. An example of this is the term Machine Learning, if translated literally it would not make any sense for people who are related to AIED, so it is necessary to look for an equivalent that fits perfectly with the environment mentioned. For this reason, it was necessary to apply specific translation techniques such as *Borrowing, Literal Translation* and *Equivalence*, which were applied depending on the case of the term.

In terms of linguistic difficulties, the following were identified: semantic voids and acronyms. The first difficulty arose when trying to translate words such as *Google Classroom*, *Coursera*, *Moodle,* just to mention a few, which are impossible to translate as they are terms from a specific language, in this case belonging to AIED. The researcher did a search in different documents where he discovered that these terms are indeed maintained in their native language, so the equivalent was not sought.

The second problem was noted in terms based on acronyms, according to different translation websites' recommendations, it is possible to translate those acronyms that already have an established equivalent, for example "*AI (Artificial Intelligence)",* whose Spanish translation is *"Inteligencia Artificial (IA)"*. Indeed, there were some terms that caused confusion to the researcher, one of them was *"STM (Structural topic modeling)"*, which turned out to be *"Modelo de tema estructural (STM)"* and the translation of the acronym does not apply since it is a very little diffused term. As in the previous situation, a review was made in various documents as well as using resources such as Collins Online Dictionary and Linguee to provide a more accurate translation.

Having mentioned the above, it should be clarified that the researcher had no previous experience using the AntConc program and had to watch videos for the installation and use of the program. The researcher had to investigate which digital tools were suitable for making a glossary and which were compatible with the Excel format, the document where the terms were found. The consultant was of great help in this process, as he recommended programs that were suitable and, above all, easy to use for beginners like the researcher.

Overall, the monographic work provided the researcher with more knowledge of concepts belonging to AIED and also of digital programs that were useful during the creation of the glossary, giving it an innovative characteristic. The use of the Interpreters' Help tool, as its name suggests, offers support when creating and editing a glossary. Among its functions, the user can find the option to create a glossary manually where the number of columns and their categories can be added. In addition, this resource gives you the option to import terms from a Word or Excel document and you can also create your glossary using the option to extract terms from a text. This programme is useful for interpreters, because through decks of flashbacks you can review previously created terms, so it is also dynamic. In the Glossary Farm section, it is possible to find public glossaries of different interests that may benefit another interpreter who shares the research topic.

In addition, this work achieved the main objective which was to provide a reference tool for students and teachers who require a translation or equivalent of concepts that are commonly used in the field of AIED. As for the specific objectives, this work seeks to be accessible to those who may require concepts in this field such as translators and researchers who are interested in the same subject and to present a methodology for the creation of a glossary with technological tools to students who are interested in creating a bilingual glossary. The researcher considers that this glossary will undoubtedly benefit any user who requires information on the selected concepts and can be of support to other students who are interested in the subject of AIED. Nevertheless, it should bear in mind that the topic of AI is very topical and new terms may continue to emerge as the years go by, so perhaps this glossary may not be as useful by then.

To conclude, although it was believed that the glossary does not require so much time to produce, the truth is that if you want to deliver quality work you must be patient and very disciplined, and sometimes it takes a lot of time, however, every effort has its reward so that at the end of it all, the work will be worth it. This work made the researcher very proud, and she hopes that those who read this glossary will find it useful, which is the main objective, to contribute to society in a satisfactory way.

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