



## A Novel Architecture for Smart Learning based on Soft Computing

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framework.

### Abstract

The student learning system (SLS) is a method of assessing a student's awareness and comprehension of a specific subject. In this technological world, SLS has become a more viable option for a range of people from beginners to get knowledge and the experts to get updated in learning. In the last years, artificial soft computing techniques have been applied within the learning architecture for providing an effective learning environment. A systematic study of soft computing applications is carried out in this article in order to improve the learning system. Various soft computing techniques and their architecture with respect to the E-learning and m-learning methods used and their implementation are also discussed. The purpose of this paper is to look into the use of soft computing to provide users with observations and enable them to prepare, using tools specifically for challenges in learning and proposes a model based on Artificial Intelligence (AI) for learning techniques. This paper has found the development of techniques using soft computing as a source for handling learning methodologies more effectively.

**Disciplinary:** Education Technology (Smart Learning), Computer Science (Soft Computing).

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## 1 Introduction

One of the primary objectives of educational programs is to improve student learning success and satisfaction. Accurate assessments of the various competencies are needed to adapt the teaching process to the needs and interests of each student and instructor (Han et al., 2019; Zantalis et al., 2019). In a learning environment, an expert teacher is conscious of the students' varying degrees of success and cognitive capabilities. However, due to the size of the classroom and the consistency of the teacher's assessment process, every teacher's ability to change the

educational environment to efficiently teach each student at the same time is limited (Han et al., 2019). As a result, reduced class sizes will aid in the precision of studying and interpreting such attributes, allowing teachers to concentrate based on each student's needs and demands (Han et al., 2019). Many studies show that, in comparison to community schooling, one-on-one instruction leads to better educational outcomes (Osman and Khan, 2019; Bernard et al., 2015). In conventional classrooms, though, providing such focus and instruction can be difficult.

E-learning can be described as an electronic teaching strategy in which guidelines are created or configured to facilitate student learning and then distributed to targeted recipients by smart devices such as Personal Computers (PCs) or handheld platforms (Aydoğdu, 2020). E-learning can be structured in two ways: one as teacher-based learning called synchronous e-learning, and the other as self-based Asynchronous e-learning is a form of individual research (Aydoğdu, 2020). When learners enroll in an asynchronous e-learning course that uses speech or image-based texts, pictures, graphics, or video as learning resources and includes assessments, the students are given the option to monitor the time and location and also the speed where they want to focus on their own education (Aydoğdu, 2020; Bokoro and Doorsamy, 2019). Another e-learning style, known as synchronous e-learning, is real-time teacher-based training, which is structured for learning instructions to be given or guided in real-time by a teacher (Aydoğdu, 2020). This form of e-learning which is normally distributed in real-time uses a variety of communication tools often over the Internet. Unfortunately, it seems that these e-learning settings, which may be asynchronous or synchronous learning environments, have similar issues as traditional classrooms leading to a shortage of engagement, which means that the diagnostic mechanism among students and teachers cannot be completely implemented. Furthermore, e-learning courses are available and tailored for all students, regardless of their independent skills and requirements (Kebritchi, 2017; Engle, 2006).

Advantages of an Intelligent Learning System:

1. A better grasp of the situation applications of soft computing-based technologies in the learning system.
2. Effective implementation of soft computing-based techniques in learning management. This should be done in order to identify the most effective methodology for learning.

## 2 Methodology

A review was conducted for articles on intelligent-based learning systems, applications of soft computing in intelligent-based learning. The features and implementations, the capabilities, the duration, and the number of articles reviewed are all discussed in this document. This review aims to provide answers to the research questions:

- (1) What is intelligent based learning and what applications have been developed for it,
- (2) What are the uses and advantages could soft computing technology bring to intelligent-based learning?, and
- (3) What are the uses and advantages of implementing soft computing techniques in intelligent-based learning? And a suggested framework focused on the integration of AI and machine learning for establishing effective learning.

Our analysis approach was based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) checklist. This study also discovered the uses of AI of in learning methodology.

## 2.1 Relevant Articles

This section describes the relevant papers and the method of selecting them for this systematic examination. We searched seven broad scientific databases to find related papers for this review: IEEE Xplore, ACM digital library, Taylor & Francis Online, Science Direct, Journals, ProQuest, Springer, and Web of Science. An advanced keyword-based search process is also used to accomplish this. In the process, the following terms were used: “soft computing AND intelligent based learning,” “ANN AND intelligent-based learning” and “soft computing AND CNN in intelligent based learning”. The search based on Google Scholar yielded several articles. The primary goal of this search is to locate additional high-quality papers that may have been overlooked during the primary search in research journals.

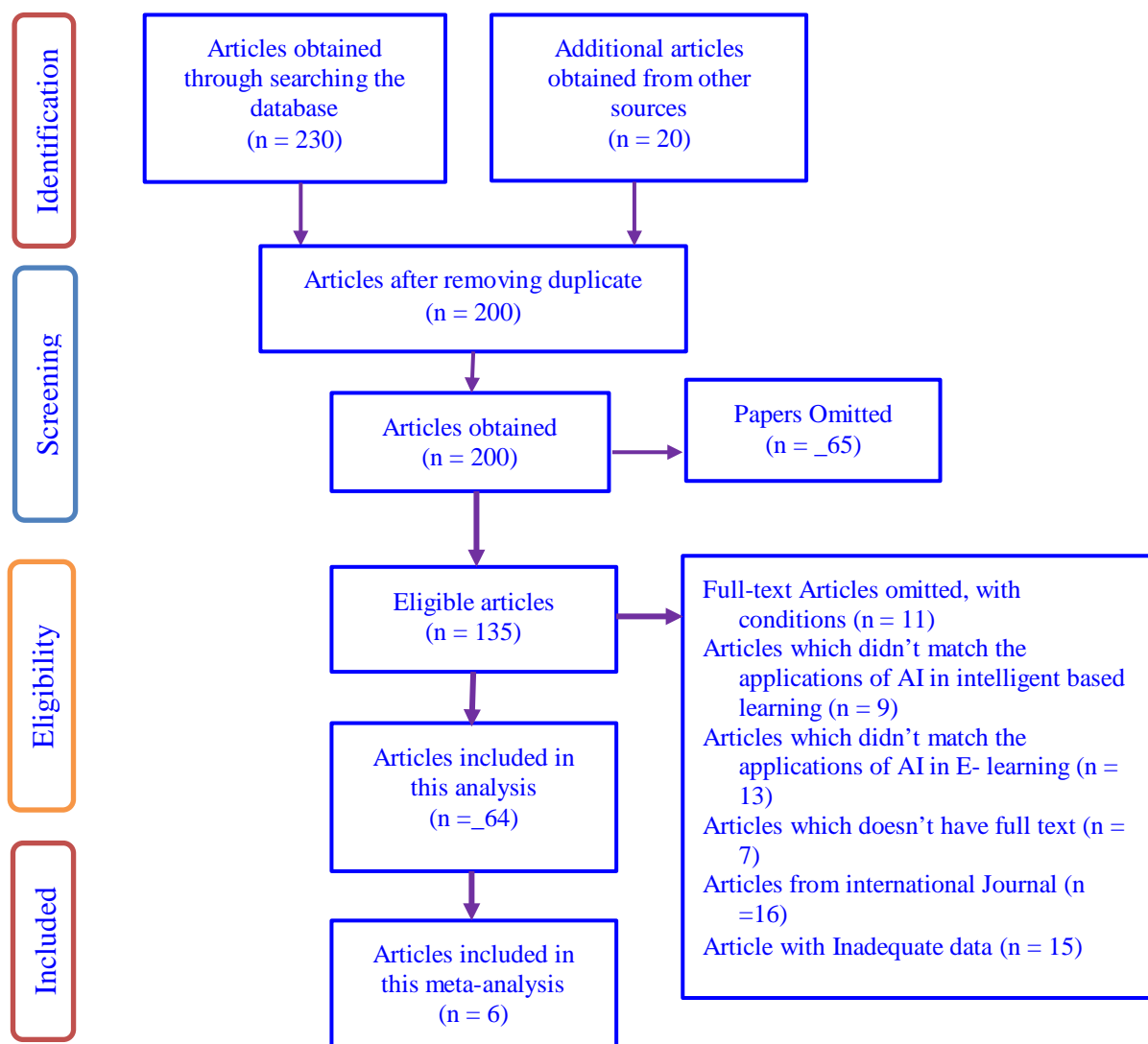


Figure 1: PRISMA flowchart for the entire review process.

## 2.2 Inclusion and Exclusion of Articles

After concluding the journal search, the researchers used an inclusion and exclusion criterion to hide the abstracts and titles of the papers found. Papers that are not in English, papers that lacked an entire article, papers that did not reflect soft computing applications in intelligent-based learning, and papers with inadequate information were all omitted. Duplicate papers were also deleted from the database. Finally, papers were collected and stored for analysis. The above procedure is depicted in Figure 1 as a PRISMA flowchart.

From the seven research databases, a total of 250 papers were retrieved. Then, using Google Scholar, other alternate papers were also discovered. During the preliminary selection period, a total of publications were ruled out. The following papers were excluded: papers that did not depict AI applications in intelligent-based learning, articles that did not depict soft computing applications in learning, articles from international journals, and articles with inadequate information. Figure 1 shows the flowchart of Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA).

## 3 Intelligent-based Learning Systems

Intelligent-based learning is an advanced form of education. It defines new paradigms for learning that perform the students to have an environment that is more effective for learning [29]. It also offers a personalized technological environment for learning with the applications of computing-based systems. Intelligent-based learning offers the following features for the learners.

- (i) It focuses on the content of learners based on advanced computing-based technologies
- (ii) It is an intelligent based effective and tailored learning methodology based on the advanced infrastructure of Information technology

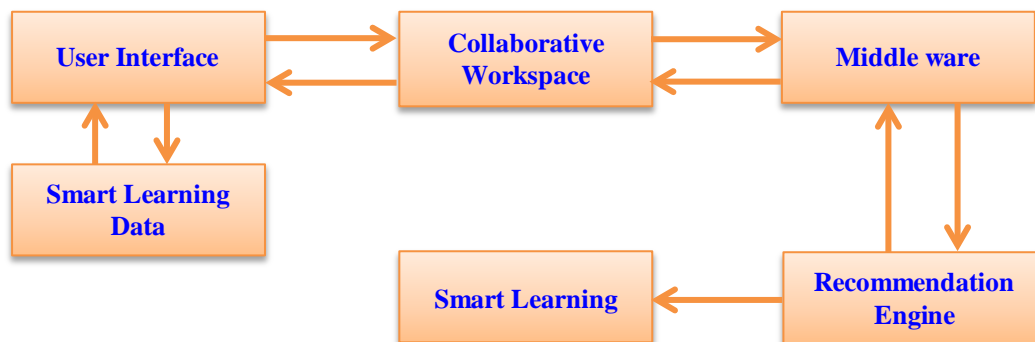
### 3.1 Smart Education

Smart education emphasis the implementation of IoT in higher education. This is done in order to signify the new way of interactivity among the students and the teachers for generating a smart-based academic environment. It proposed architecture for the combination of IoT and smart education that mainly focuses on all the various challenges and issues shown in the previous sections. This architecture outfits interoperability, maximum reusability, and scalability, etc. The architecture must be pliable in nature hence, that it can be easily modified and incorporated in order to modify based on the needs of the future. Figure 1 shows the schematic representation of a smart college for delivering a smart education. This comprises smart learning techniques, smart teachers, smart classrooms, smart learners, and smart educations. Smart education highlights the principles of focusing on better education. This mainly focuses on the necessity for smart pedagogies as a methodology for the environments which are focusing on smart learning. This also maintains the goals of education to produce smart learners.

### 3.2 Smart Learning

Smart learning (S-learning) is an advanced form of education. It defines new paradigms for learning that perform the students to have an environment, which is more effective for learning. It

also offers personalized technological environments for learning with the applications of computing-based systems. The overall structure of the smart learning environment is shown in Figure 2.



**Figure 2:** The overall structure of a smart learning environment.

This smart learning offers the following features for the learners.

- (i) It focuses on the content of learners based on advanced computing-based technologies
- (ii) It is an intelligent based effective and tailored learning methodology based on the advanced infrastructure of IT.

### 3.3 Soft Computing-based Smart Learning

There are two primary categories of computing models in computer science. The first is soft computing while the other type is hard computing. Soft computing relies on artificial intelligence and algorithms (Chandwani et al., 2015; Chandrasekaran et al., 2010; Tiwari et al., 2010). Various soft computing-based techniques were proposed by earlier researchers. A fuzzy logic-based Fuzzy Expert System tells the difference between such bright and participants with low I.Q. Its primary goal is to adapt learning to the level of each student. Taylan and Karagözo (2009) developed a modified fuzzy logic-based learning evaluation model for students to measure their academic success by collecting data and presenting outcomes to correlate with statistical output. Adaptive Neuro-Fuzzy Interference System (ANFIS) can improve the speed, accuracy, and versatility of existing systems. This fusion of neural networks and fuzzy logic can select a set output with pinpoint accuracy. The genetic algorithm can also be used to evaluate student results. This method aids in determining the most significant factor influencing student excellence. The marks earned during a student's educational career are taken into account when assessing their results. Xenos (2004) proposed a Bayesian Network (BN) method to identify various learning styles in the participants. When compared to the existing model, the findings were more reliable. This model aids in the precise identification of students. A Bayesian model can also distinguish among changes from A to B with greater accuracy. It is also effective in identifying the tutor's mistakes during evaluation in order to avoid repeating the same mistakes again, as well as identifying positive activities that could be useful in the future.

## 4 Soft Computing based Smart Learning and Smart Classrooms

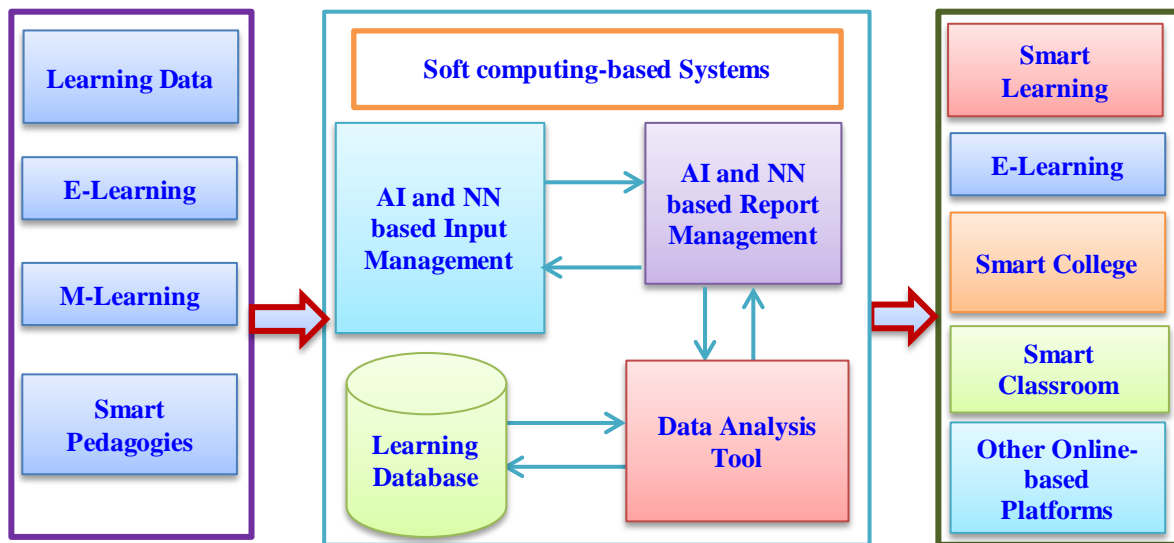
The AI-based Smart Learning and Smart Classrooms consist of user perspective, verification, user interface, speech command-related applications, and its recognition, controlling the attendance using an attendance application, gesture triggered commands, etc. Communications in a smart classroom, among distinct devices and the consumer are treated by the AI-based algorithms through the gateway. A network gateway is placed between the devices depicts that the design of the AI-based smart classrooms model is based on IP networks such that every classroom must have a private IP network of its own for controlling the devices. Various works have been done by different researchers in the field of Learning based on ANN. Ahmad and Montazer (2009) proposed a customized multi-agent E-Learning framework based on the combination of Item Response Theory (IRT) and ANN. Adaptive tests and customized recommendations were shown in their system. These experts contribute to the learning situation with adaptation and intellect and serve as a human instructor who guides the learners through a well and personalized teaching situation. Bernard et al. (2015) introduced an ANN approach to identifying the learning styles of understudies (Richa and Vidushi, 2018). Khandelwal et al. (2020) implemented the Updated DA model used to measure the output of student grades to acquire scoring from old datasets to determine new features using an ANN.

**Table 1: Summary of Artificial Intelligence Models in Smart Learning**

No	AI Model	Main Area	Applications in Smart Learning
1	Convolution Neural Networks	Face Recognition provides model-based learning	Expect the dependent variable of the tools for learning (Shen et al., 2014). Usage of facial expression to identify the thoughts of learners (Sun and Huang, 2017).
2	Recurrent Neural Networks	Speech recognition, Prediction of feedbacks	Obtain the sequential events and interactions in the design Deliver a strong precision in recognition of speech & character and NLP-based assignments (Rikkert et al., 2018).
3	Deep Learning-based Neural Networks	Online presentations,	Supports the virtual presentations more precisely.
4	Item response theory and ANN	Personalization of E-learning system	A customized e-learning system focused on multiple agents that provide predictive tests and customized e-learning systems (Pao-Hua and Menq-Jiun, 2009; Ahmad and Montazer, 2009).
5	Deep belief network	Natural language processing (Ruhi et al., 2014), speech recognition (Dahl et al., 2012; Seridi et al., (2006).	This model provides good accuracy in understanding the natural language and speech recognition.
6	Artificial Neural Networks, K-Nearest Neighbor	Performance prediction of students	This model predicts the Students' grades and also focused on their results which are scored in the e-learning management system (Tanner and Toivonen, 2010; Aydoğdu, 2020).
7	Self-Organizing Map and Back Propagation Neural Networks	Recognize the connection between both the content of learning and the learner's necessity for learning.	A combination of personalized AI-based system which is used to select the learning objects for each student (Idris et al., 2009).

## 4.1 A Proposed Model of Soft Computing based on the AI-based Smart Learning

The proposed model includes three key components, including user learning data from various devices, AI and agent-based frameworks, and smart learning-based tools. Figure 3 displays the overall architecture of the proposed framework.



**Figure 3:** Architecture of the proposed Soft Computing-based Smart Learning system.

The whole schema of assessing various formats of information is derived from the different learning systems. The fusion of the AI and NN-based systems processes this data. Two components part of the AI-based system were the information management module and the document management tool. The main aim of the proposed system is to employ AI-based technology for processing the user's inputs. It is also used as a platform for input management, report management, and data analysis tool. The AI-based report management module obtains, analyzes, performs, and triggers the action by, classifying the user input using the free text approach. In the learning database, all the analyzed sources have been stored and modified. This module comprises multiple features, such as learning-based information storage and a tool for data processing. The data processing tool collects the input information, processes it into datasets, and sends it to the report management module based on AI. All the queries and sources that were handled are provided as feedback to the smart learning system. This model improves the overall accuracy of intelligent learning because the AI and learning methodologies were combined.

## 4.2 Implementation of the Soft Computing-based Smart Classrooms

The smart classroom is primarily used for the training of university courses in the classroom. The intelligent classroom will be a place for learners to learn theoretical information and movements. Smart classroom design is split into two parts such as spatial design and technological design. The room is accurately planned and the teaching facilities are fairly distributed and the features of complex combinations are realized to the greatest extent possible, in order to have an evolving learning atmosphere for the learners. The technological architecture focuses on smart

management and centralized control, and the different units and devices are interconnected to achieve a high degree of wireless-based network functionality.

The smart classroom's fundamental devices are the monitor, smart chalkboard, floor, etc. Features such as presentation of content, management of the environment, sharing of resources, and circumstance acquisition will be realized through the introduction of the smart classroom to the instruction of the University course. The Hardware requirements and software requirements for an AI-based Smart Learning environment are shown in Table 2.

**Table 2: Hardware and software requirements for an AI based smart learning environment**

Hardware/ Software	Name	Description
Voice Recognition System	Sensor	3
Face Recognition system	High Resolution Camera	3
Development Language	Python	3.0
Database Core Server	MySQL	5.5
Database Management Tool	MySQL Tool Kit	5.1
Server	Apache Tomcat	6.0
Operating System	Windows 7	Ultimate
NAT Gateway	Private Network	External IP

## 5 Limitations of Soft Computing based Smart Learning

Among the unique benefits of this AI-based smart learning, some disadvantages have to be taken into account: a large segment of the population, the system could not be too precise, have to rely entirely on technology, many concerns of privacy and protection. With respect to a significant portion of the population and also because of the size, their inability to attain it, and the slowing expertise and skills to employ it, exposure to a smart learning-based framework is refused. In order to remove humans and their assumptions, the machine cannot be too precise. The learning methodology has been made simpler by these programs, but it cannot be a replacement for tutors. Also, even a well and technologically better software could never be 100% precise.

These smart learning methods often allow a consumer to be completely reliant on them. There is a chance for all the data to be lost momentarily or even indefinitely if the user loses the user id/password. There could be a possibility for the confidentiality and protection of the information contained in it to have different problems. In such situations, malicious users indeed can modify the data.

## 6 Conclusion

E-Learning can be described as an integrated learning-based software system that synthesizes computer-mediated interaction of software functions and methods of providing teaching materials. Similarly, the application of AI in learning is one of the most important achievements for the intelligent-based education system. To improve existing learning methodologies, AI-based learning environments can be used to provide personal services improve the skill of the learner and faculty by interacting with the learning system. In this paper, a detailed review of various applications of AI in smart learning is done. In particular, all the benefits of specific technical areas and components of learning methods such as smart classrooms, smart



teaching, and smart learning are described in detail. Applications of various models of AI such as the ANN, RNN, CNN, Deep Learning based Neural Networks in the learning process are presented. Several pieces of research such as customized learning models and self-learning were investigated for the use of AI in tutoring and learning techniques are done. The roles of different AI-based methods within the current model of learning management are also highlighted.

## 7 Availability of Data and Material

All information is included this work.

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