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Adaptation in the E-learning systems

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Abstract. Considering the weakness of traditional e-learning, a multiple of e-learning systems attempt to get individualization into the process of learning by offering learner-centred instruction, the adaptive E-learning system (AES) is seen as one of the more famous models. An AES can tailor its response to different circumstances. This system aims to improve and execute a solution framework for personalized instruction according to a real-time singular difference in education. In other words, AES concentrates on adaptively delivering learning materials. In this survey paper, the AES framework has been discussed with its components, the technologies, and tools employed by this system. Also, this paper discusses some studies that approved the importance of adaption in the e-learning system in the years (2018-2020), and introduced some challenges faced by this system.

Keywords. Learning, AES, adaption, Technology, challenges, Adaptivity, Adaptive learning environment

Introduction

Learning is one of the fields of study that has drawn the interest of many researchers over the past few decades. Despite its complexity, numerous works have raised interesting issues, particularly the issue of accessibility of learning resources is to ensure "learning for all"[1]. The learning system based on formal teaching, with the assist of computers and continuous interaction via the Internet with the trainer, is known as electronic learning (e-learning) [2]. It is a grid of a major number of grantees who are empowered with participated information and skill transfer simultaneously or at a different time [3]. E-learning employs educational material beyond a traditional classroom using e-technology. Often, it is a program, course or degree offered completely online. Many idioms are utilized to explain learning that is delivered online, like Distance Education, online learning, computerized, internet learning, electronic learning, and many others. These days have proven the importance of e-learning, especially as we are in the COVID-19 pandemic, and this situation has overturned out traditional learning. This situation forced all educational institutions around the world to impose e-learning to preserve the safety of students and teachers [4]. Hence, the importance of e-learning becomes evident, as students receive lessons and learning objects via the Internet, also classrooms and lectures are registered so that they can access them when they want. This pandemic has not hindered the educational process, thanks to e-learning.

As a complicated system, electronic learning comprises individual and group learning operations, teaching materials in different forms, and tutorial and interactive action.

To raise the efficiency and effectiveness of this system, it is needful first to consider the students' properties, their styles of learning, and their background about lessons [5]. In education, the arranging of the information and learning materials according to the students' needs is crucial [6]. These frameworks are capable of integrating various content to be capable to reply to various learners' and to avert cognitive overload.

In e-learning, adaptation is a well-known term with the potential to expand its use in modern education systems. A pupil study and learn to gain knowledge independently depending on his way to learn and what he prefers. The goal of adapting e-learning systems is to supply effective learning by providing students with the chance to contact an environment that recognizes their knowledge, attitude, and needs [7]. The adaptive e-learning merge characteristics of learner like skills, style of learning, and knowledge level to offer adaptive learning and advise related learning objects(material) of education [8].The structure of the paper presented as follow: first section after the introduction is the background section that presents the history of this system, the second section presents the types of adaption, the third section introduces the Architecture of this system, section fourth list some technology and tools used by adapting e-learning systems (AES), after that, some studies have been presented, motivation and comparative analysis have been written in section seven and eight, then section nine list some challenges faced by this system and last section conclude with the conclusion.

Background on adaptive e-learning systems:

It is possible to trace research into AESs back to the early 1970s. Computer-based learning was explored at that time by integrating Artificial Intelligent (AI) research and education [15]. Intelligent tutoring systems (ITSs) were born as a result. They aimed to imitate human tutoring's capacity to direct learners through personalized guidance and advice during the problem-solving process [15]. Later, and by availing on the technological improvement, particularly in the computers field, many researchers with diverse backgrounds have participated in developing a novel generation of educational systems that adaptive online through different models and approaches proposed by them [15]. At their core, these systems aim to permit interaction and adapt resources of course and other educational activities to present a unique experience to every learner. To attain this objective, an AES depends on an adaptation model that performs rules describing the strategies of adaptation for each situation of the learner.

According to the vocabulary of Oxford, the concept of "adaptive "is known as "the possibility of changing" wherever necessary to adapt to various situations [9]. In the e-learning system case, the term adaptive indicated the combination of approaches and techniques that are joined with each other to provide online learning objects to the students to provide customized interfaces and resources [10]. In the last years, AES has arrived at the fore. This system is a more active and efficacious web-based smart way of providing online training and learning. AES concentrates on personalizing the learning materials and courses to the individuals learning characteristics. The efficiency of these systems is higher than conventional learning management systems (LMS). Several solutions, including similar activities, adaptive content, adaptive collaboration systems, and solution analyzers implement their particular functions more effectively in order to meet the requirements and preferences of learners [10]. The system itself undertakes user wants. Learners cannot adjust parameters of the system according to their needs; he doesn't have the authorization to change it. The system alters its action and behavior within the supposed needs. Another advantage of these systems is that gather data and info about the learners in the way they see the user [5].

Types of adaptation

The types of Adaptation listed as following:

A. *Adaptive Course Delivery*: techniques of adaptation, that relate to the course amendment to an individual learner. The major objective is to connect the content of the course and the properties of the learner to accomplish the ideal results of learning. Typical instances are personalized chosen of course content, adaptive navigation, and dynamic course restructuring etc. [5].

B. *Adaptive interaction*: It points to the adaptation that occurs on the interface of the system and, without changing the content itself, provides the ability to reinforce and promoting the engagement user-system [5].

C. *Adaptive Collaborative Support*: this type refers to learning prop from where organizing connection among participants and concentrating on common aims [5].

D. *Finding and creating content*: adaptive techniques implementation in creating and detecting these contents that agree to the student's properties and the course contents [5].

Adaptive e-learning systems architecture

AES on the way the students studied and learned, the cognitive framework, and the meaning of learning materials [5]. The adaptive e-learning system structure comprises three models, as shown in Figure 1.

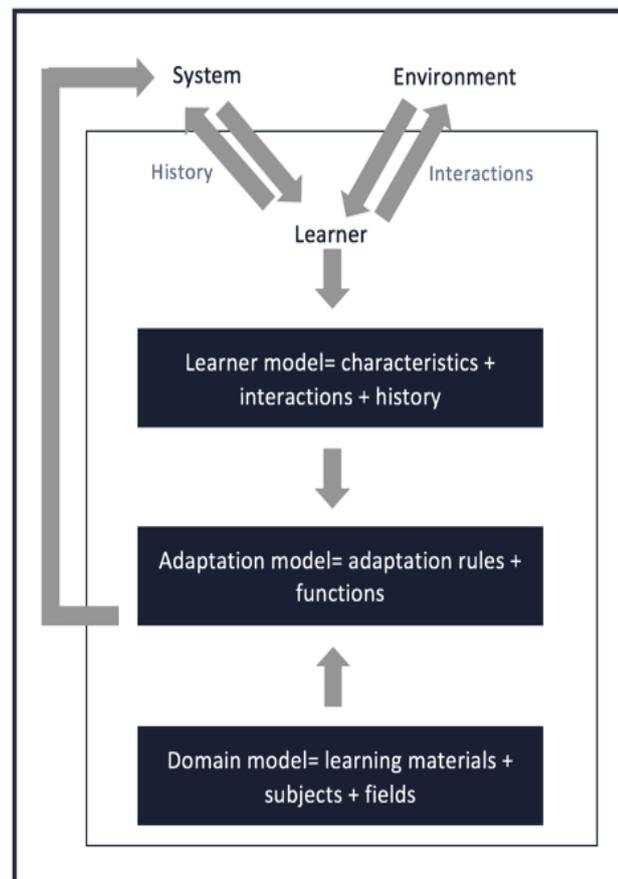


Figure 1: AES Architecture

AES consists of three models: Adaptive Model, Domain Model, and Learner Model. As we see in the figure 1 model of learner comprises the information for the learner. In contrast,

information and the knowledge about the courses include in the domain model, and adaptive model from its name transacts with the mechanisms and techniques to present the styles of learning and various material for the relevant course [11].

A. *Learner Model:*

This model holds the learners' personal information like learning pattern, their domain, and level of knowledge [11]. It not just stores the information but also traces the users learning registers [12]. Information relating to this model is split into two main classes; Domain-specific information and industry-independent one [13]. Information in the first category about everything linked to knowledge, learning behavior, understanding level, and skills, etc. The Second category depends on student skills and is therefore focused on their behavior. It can include learning objectives (to assess the learners' accomplishments), cognitive skills such as inductive reasoning skills and associative learning skills, learners' motivational states, context and experience, and interests [13].

B. *Domain Model:*

A domain model provides knowledge of the content area of the shore-based adaptive course submission [13]. It works through a data warehouse consisting of pages, contents, topics, and browsing links relevant to the design framework of the data being represented. Nevertheless, this model may also contain learner information relevant to the learning activity, like workflows, roles, and participants [13]. Delivery system and course content considered two major parts of the domain model [13]. The delivery system must be able to shore all content kinds and adapt to various course content demands [13]. The significant side of the domain model is the relation among the course elements utilized to determine upon adaptations [13]. This model concentrates on designing structures that are suitable for the needs of user and characteristics. These content structures make it appropriate for students to get what they want from data and topics.

C. *Adaptive Model:*

An adaptive model includes the adaptive theory behind an AES by using a combination of the student model and the domain model [13]. The adaptive modeling operation starts by analyzing students' needs from the learner model by selecting representative nodes [13]. Nodes can be categorized into several types of knowledge: basic knowledge, knowledge of formulas, definitions, and other matters; procedural knowledge, treating relations between steps; and conceptual knowledge, pointing to relations among notions [14]. Each type of knowledge request various strategies; thus nodes will be offered to learners in various fashions [14]. The following step is to create a decision about which objects of learning from which nodes must be performed so that learners can utilize them till they are terminated with that node. The final step is to reiterate the process till every node is thoroughly selected [14].

Learning Analytics (LA) and AES are two integral approaches to observe learners' activity. The main objective of LA is to improve a paradigm that tries to prophesy the attitude of learners and futurity performance, according to their present actions and accomplishments [16]. To obtain these objectives, LA utilizes various procedures and techniques like Business Intelligence (BI), and Social Network Analysis (SNA), Information Visualization (IV), Statistics, and Data Mining (DM) [16].

Technologies and tools used in (ALS)

1. *Business Intelligence (BI):* it is a collection of methods and principles that are utilized to make business decisions via a support system. It comprises architectures, databases, applications, and methodologies [17]. In the field of education, it is applied to explore learners' actions and activities under various perspectives, the visualization report, and the

dashboard. It is employed to develop teaching and observe learners' activities utilizing log files of data for the system of e-learning [18].

2. Data Mining (DM): refers to the operation used to analyze and implement data from Web, database, picture in multiple perspectives and briefing it into beneficial information [16]. Several surveys have shown that methods could successfully and skillfully be integrated into e-learning area. It may be utilized to overcome prediction and classification problems in the area of e-learning [16]. Evolutionary computation, Fuzzy logic networks, association rules diagrams and artificial neural networks are the most common mechanisms, used to solve these issues [19].

3. Statistics: Many current systems for e-learning execute tools of reporting that offer statistics of the interaction of learners. In the e-learning, statistics produce an easy statistical process like sum evolution, normal distribution, and standard deviation [16].

4. Information Visualization (IV): refers to techniques offer a dashboard of visualization for learners and teachers. It represents the outcomes of methods of LA in an easy-used visual form may smooth the translation and the analysis data of the e-learning, these techniques, including Bar chart, Distribution plot and Box plot.

5. Social Network Analysis (SNA): refer to mechanisms and procedures that have been used in various LA works. The SNA represents a quantitative study of the relationships among system and learner [16]. Below figure lists some tools used in an adaptive system and how they work.

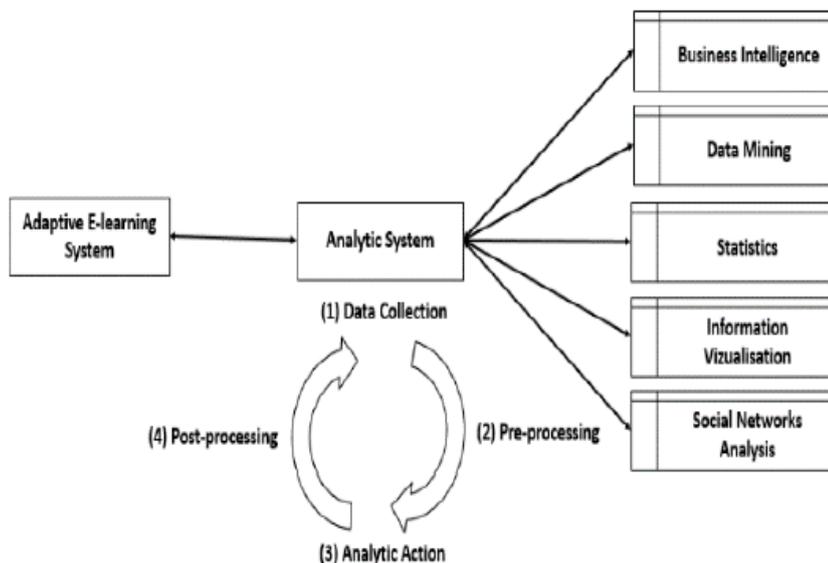


Figure 2: Learning Analytics tools used in AES [16]

Researches in the field of adaptive e-learning are ongoing, as models and approaches have been proposed to enhance the adaptive e-learning environment to provide an appropriate educational system for every student who has different behaviors or backgrounds. In this section, the focus will be on the most prominent studies of the past ten years that have contributed to the development of the learning environment and the results were impressive.

Application of AES (studies):

• Saving Time of Tutorials

There are many unresolved matters in environment of Adaptive e-learning that make it hard for intern teachers to gain suitable data about the behavior of student. The LA growth presents modern possibilities that contribute to resolve and fix problems of Adaptive e-learning system [16]. Salma Janati et al. in [16] proposed a framework of Business intelligence for Adaptive e-learning framework to guide learner performance more efficiency. They propose a model of the data warehouse that replies to these problems. They suggested a framework which attempts to fix the shortage of reports analytically according to AES. This approach offers administrators detailed reports to estimate and implement activities of learners. It permits teachers to analyze the learner’s behavior to develop the fineness of the education and define the appropriate decision. The study displays that student ordains little time on tutorials and courses and prefer to employ cooperative activities and actions, like forums and virtual classes, instead of looking at resources of learning.

• Improving systems of learning

In [20] author discusses the personalization of learning process for learners based on individual characteristics has currently be important topical, for that he suggests a technological approach to improve AES, rules of its elaboration its framework and ingredients. The novelty of this scientific study consists in constructing the learning materials as a hierarchy of idioms, process and algorithms of personalizing materials of education, and model of estimation of learning results which offers for the estimate of subject-level competence improvement, the course of adaptive e-learning operating on Moodle LMS was improved and enhanced according to the adaptive systems. It was executed in the learning operation of engineering pupils Information Technology department at the University of Siberian. The technological approach has been created to development of AES of web based teaching, to characterize its framework and components.

The framework system holds the adaptation model, the pedagogical learning content model, the learner model, and the education results assessment model shown in fig.2. AES's assessment model is responsible for defining the subject-level efficiency improvement of the learner by appreciating all its components: skill component, Subject motivational component, knowledge component and reflective component (fig.3). A questionnaire between pupils showed that utilizes this adaptive system helped form the coherent conception of the discipline, raised stimulus for study the learning materials.

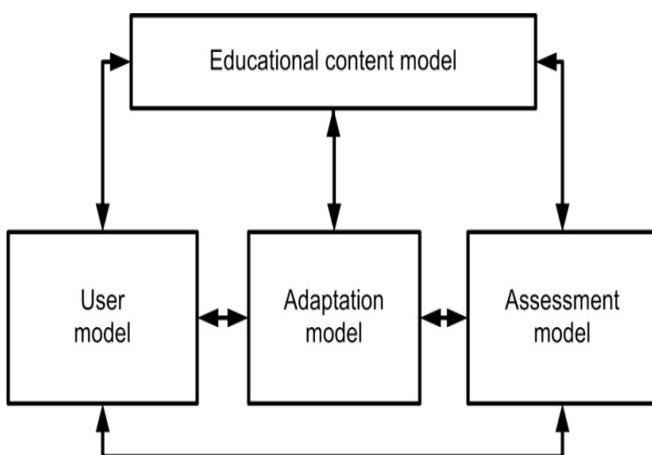


Figure 3: adaptive system Scheme of web-based teaching framework [20]

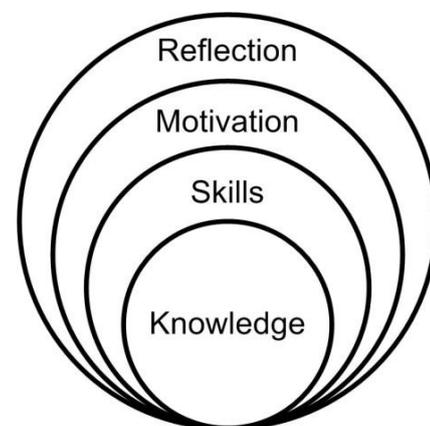


Figure 4: Subject competence structure [20]

According to the studying experience with this system, the learners pointed the following favorable factors: a chance to study the education material presented in a easy-formed; improve the efficacy of work of classroom when pupils attend classes known with the theoretical materials.

• Enhancing reading skills

Adaptive e-learning is an efficient approach for primary school learners to understand [21], it has a more efficient impact on the pedagogical side and more cleared for low-level learners, particularly for girls and for older students. The result when using this platform was its fits into lessons while achieving its goal: improving student success in reading understanding.

• Concentrate on the assessment component in e-learning

The assessment is one of the most critical elements of the learning operation. Generally, the evaluation is a broad concept that involves a detailed collection of procedures utilized to collect learner's information of its education and make a judgment on its advancement [22]. Notwithstanding this deciding position of estimation, it must be observed that the operations related to the online learning assessment are too bounded in most e-learning systems.

Process of Assessment: Conceptualizing the process of adaptive e-learning to its basal items, items could be defined [23]:

- The learning content to be educated
- The activity of assessment to estimate the education of the learner
- The score outcomes gained.

The profile created is depending on essentially on the results of the score and the personalization as well. The following figure displays those items that describe the process of assessment within AES

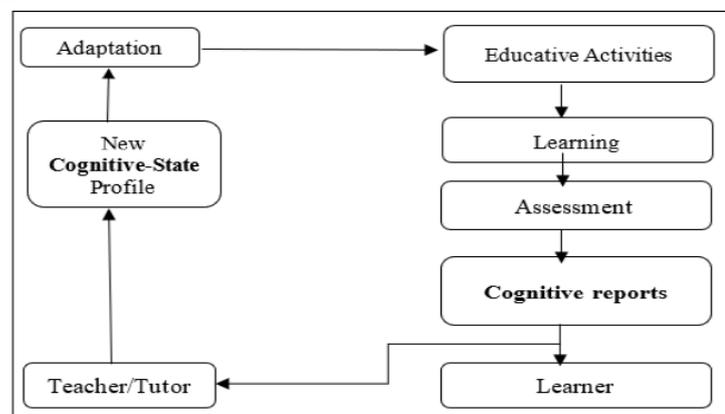


Figure 5: Proposal process of Assessment in AES [24]

As we shown in fig.4, a Cognitive report tool has been added to the assessment process of e-learning, this tool provides feedbacks for teachers and learners. Feedback indicates to the securing information process permitting adjust through modification or standardization of efforts to get an individual near to an intended target [24]. To realize the major aim of the activity of assessment, the suggested tool offers two report kinds which include beneficial feedbacks for both instructors and pupils. During these report, students know everything related to the subject in the learning process, and instructors know about if the students make erroneous thinking and assess Whether or not the methods he used during his sessions of teaching are ideal; and what to alter for remediation.

• Finding optimal pedagogical content

As the population increases rapidly and wishes to learn online, platforms of e-learning want to adjust and innovate how to give learners courses [25]. There are various ways and methods in literature to try to identify the best courses for learners like those focused on algorithms such as genetic algorithms. Companies and researchers have been using the basis of recommendation systems in e-learning recently [25].

In the platform of e-learning, different learners' types are there, so the platforms should search new ideal approaches to consider all the learners' preferences, and also for increase the learning quality [25]. They suggested a new reinforcement learning and recommendation system (RS) for advising and recommending suitable learning courses to learners. The suggested (RS) has been dependent on social filtering (SF) and collaborative filtering (CF) [25].

○ SF: based on learners' profiles of social networks, SF utilizes the learners' social content to know some operators like motivation and productivity of learners. Those operators applied as pointers for clustering (positioning students with equal social content in groups).

○ CF: that consists of developing profiles of learners according to their knowledge, therefore, computing the equivalence among students in the recommendation method and extract useful information about the active student and various concepts of pedagogical purposes of courses based on the approach of enhancement learning.

The proposed platform has different steps to implementation, during the experiment in [25] the last step was the recommendation of the ideal pedagogical goal for the proposed learner.

• Modeling environment of adaptive E-Learning

The integral of two or more smart systems produce in so-called hybrid intelligent systems, smart systems like fuzzy techniques and deep neural networks [26]. In This Year, Mohammed and Ammar proposed in [26] a hybrid approach that helps to adaption in e-learning through capturing the behavior (attitude) and expressions of emotional of the learner. This may help the learning system to guide learners to other paths of learning that more suitable for them. This study suggest an approach for designing a smart adaptive e-learning system by taking into account the integral of the learners' answer to questions and their sentimental situations [26]. CNN and fuzzy system are considering the intelligence tools that help and enhance adaption in the e-learning system. Their hybrid system consists of combining a fuzzy system with the convolutional neural network. This method helps to analyze and identify a various facial expression and treats the misclassified ones based on the factors of user–environment interaction. Therefore, the fuzzy system used mainly to select features depend on the elicited expression cases comes from the Convolutional neural network and multiple response factors by the learner. At the starting of the interaction among the learner and the education circumference, initially the learning designer brings the present the learner level from the learning activities. The Education environment subsequently offers a learning tool that correlates with the learner's current level of learning (A). After the student has completed the course, the learning environment creates a session of test by the test administrator to assess the learner. When the session begins, the suggested education environment discovers and registers the learner's sentimental conditions by the component of recognition facial expression. The system walks as we have shown in fig.5.

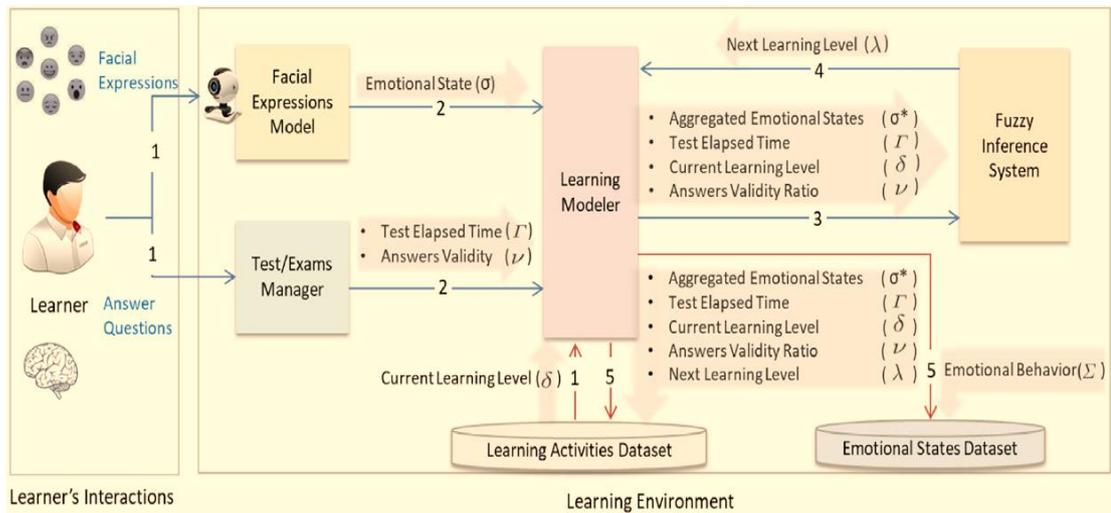


Figure 6: Suggested architecture and Flow of interaction factor of smart learning environment [26]

During the test session, we apply a facial expression detection system able to extract and to classify the facial expression of the learner. Furthermore, The student's response will be combined with the facial expression in order to give the decision of the test. This system is composed of many components explained in Figure 6, which consists of two parts, including the detection stage, then the classification stage using a pre trained model.

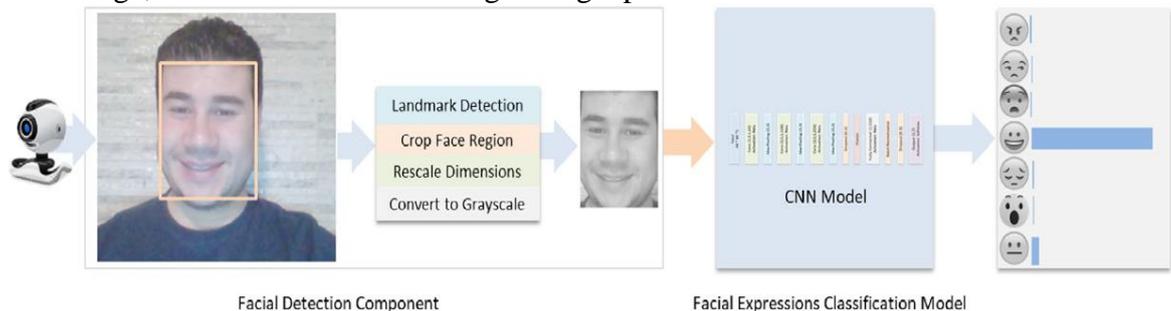


Figure 7: process of recognition for Facial expression [26]

The basic objective of the engine of facial detection section is to discover the features of the face of the learner to be fed to a classification model of facial expression targets, from its name, to classify the facial expressions of learners [26]. The factors of response of learner offered by the manager of test are elapsed exam time (B) and validity ratio of answer (C). The response factor of the learner is calculated based on learner emotional behavior (E). The parameters A, B, C and σ^* , respectively are fed to the fuzzy inference system, supplied by the modeler of learning, test manager, and component of facial expression, and generates (D) as outcome the next level of learning value, which monitors the flux of the operation of learning and helps the environment of learning in offering a novel learning materials convenient the following learning level. This study provides corpora for estimating the suggested approach performance. The corpora of twelve students include 1734 data of featured emotional faces and 72 educating activities.

The experimental findings with these groups show that the suggested approach offers adaptive education streams which fit all students in a set. In addition, the approach helps decision makers to track each student's learning output.

• Focusing in learning style of learners

The way different students learn is a learning style, it refers to a preferred way of absorbing, processing, interpreting and retaining knowledge. The importance of know the learning style of learner help in providing educational materials that suitable for their style of learning and this will make the learning process became easy and effective and more adaptive. In Systems of e-Learning, the automated identification of style of learning supplies teachers with a clear way of personalizing the learning that is accessible to students. In 2019, Ibtissam Azzi et al. in [27] introduced the importance of learning style in adaptive e-learning. They see that classification methods are commonly used for detecting learning styles. For that, they suggested a robust classifier to classify the learner's style in the System of e-Learning. The student's educational activity is recorded in various contexts, usually in different courses on a particular subject. Web-mining is utilized for catching the learners' attitudes and behaviors to extract the learning styles which is shifted to Felder-Silverman Learning Style Model (FSLSM) classes. The algorithm of Fuzzy C Means (FCM) is applied to cluster the caught data behavioral data into FSLSM categories. The proposed approach of this study is illustrated in fig.8.

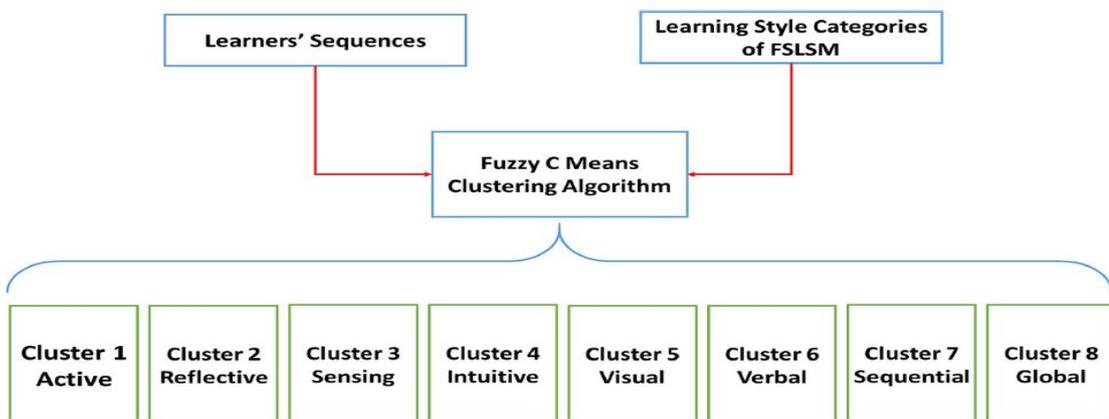


Figure 8: The suggested approach for learning styles determination [27]

The approach is evaluated by conducting some tests in courses. The exactness of both measures analyzes the efficiency of the algorithm of clustering. The outcomes show that the algorithm of FCM, in both the two tests, implements better.

• design AES for writing in foreign language

Innovative learning bigdata may help enhance the present education system structure and execute the analysis of the education techniques depending on the flux of data [28]. The foreign language writing learning process is considered as a complicated system. This process affected by numerous factors, including students, surroundings, textbooks and teachers; for that Huang *et al.* in [28] proposed an adaptive system for writing the foreign language. AES for writing in foreign language attempts to coincide characteristics of the personality of the learners with education object. This study aims to enhance the educational impact, that is fundamentally applied to online education. In this study, the Quantified Self Learning Algorithm (QSLA) has been used to analyze big data of education and achieve adaptive education. The experiment has been done during questionnaire about academic performance, education satisfaction, education time, and education interest, the analysis of the results show that most pupils think the self-adaptive learning system of foreign language writing plays an affirmative role in academic performance and enhance education efficiency [28].

• Improving EFL undergraduate writing skills of students

In [29], Rehab and Reham see that writing skillfulness is a pointer of academic success and a basal demand for sharing in civic life and in the universal society; English adult pupils have numerous causes for mastering skills of writing. Learners may want to write to implement functional missions like taking a message, filling out forms or writing email letters. For that, the authors suggest preparing a design standards checklist for directing the operation of designing the suggested personalized e-learning environment. The principle of multiple intelligence (MI) has been applied as basal for implementing the operation of adaptation since the learners were split according to their powerful intelligence into three sets (interactive, introspective and analytic sets). Various kinds of MI-based activities were introduced to each set. According to the students writing level (beginning, medium and sophisticated), these activities were also adapted.

Consequently, each pupil progressed in the adaptive environment in a personalized learning path, which was pre-determined through the learner MI profile. The experimental design was approved by utilizing sixty learners from the second year of the English language major in the College of Education in Mansoura. Those participants were split into two sets: experiential and control. Tools utilized in this study: 1) writing skillfulness (EFL) 2) analytic evidence for marking the writing skillfulness, and 3) a usability scale to estimate the facility of education of students through the personalized environment. The findings showed that the adaptive e-learning environment contributed to the improvement of writing skills for EFL students, and the students considered a learning environment appropriate for communicating with fellows and teachers.

Motivation of adaptation:

The purpose of this paper is to understand how AES contributes to improving the learning process and encourages learners to complete their education. For that, e-learning adaptation has been an important research subject. In recent decades, From above studies we can find more reasons that make adaption is essential in the e-learning environment; some of these reasons are:

- One-To-One Instruction: Adaptive learning assists in offering focused attention on persons. Existing methods of eLearning hold back when it relates to providing personalized feedback. The technology of adaptive learning utilize algorithms to accustom itself to the student demands to depend on the tasks and responses.

- Adaptive in learning assists learners to spend semi the amount of time that they take in a standard course if they have an obvious understanding of the topics. "Adaption approach" is what assists students to realize the same. Learners do not need to review content that they are already aware of. Instead of, they concentrate on the content that assists them to become more qualified

The approach of Confidence-Based: this kind of learning uses a methodology of confidence-based estimation to examine the learner's present understanding. Learners are asked to answer questions on the content they claim to be confident about. This extremely beneficial in knowing what the learners consciously or unconsciously perceive, and thus it is an indirect way to provide personal feedback and learning.

Create Personalized Learning Paths: Adaptive learning stages gather data as the learners' progress via the modules. Then used this data to aid personalize aims, content of learner and a practical path of learning for every learner

For A Heterogeneous Group: Adaptive learning is designed to all learners' types, whether they are beginners, middle, or advanced in their concepts understanding

Classification

Every study presented in this survey paper is accomplished under a set of tools and techniques that help support adaption in an e-learning environment. Here we classify these adaptive approaches under various used tools:

Business Intelligence:

- BI is a collection of instruments used for data analysis to make resolutions or decisions by utilizing data processing and loading (ETL) methods to merge data into Data Warehouse or OLAP [16]. In the field of education BI is used to explore students' behaviors from various viewpoints, dashboards, and the visualization study [16]. In (2019) the study by Salma Janatiet al. in [16] proposed a BI structure for the adaptive system of learning to observe and admin the learner execution (performance) more effectively.

The last study in this paper aim to realizing the impact of creating an environment of adaptive learning on improving EFL writing skillfulness for undergraduate learners, it used MI theory as basal to performing the adaptation process this can be classified as separate section named intelligence.

Information Visualization:

- At one of the stages in the second study in this paper [20], all the topics of the subject are ordered in a hierarchical structure, a notions tree or a set of concept trees, this study builds an educational model based on graph theory methods. The graphic theory is an 18th century branch of mathematics. Today, graph theory implementations are popular in all science disciplines and various current information and computer technologies. As we have shown in below fig. 9, the term combinations in math subject are divides as a hierarchical graph.

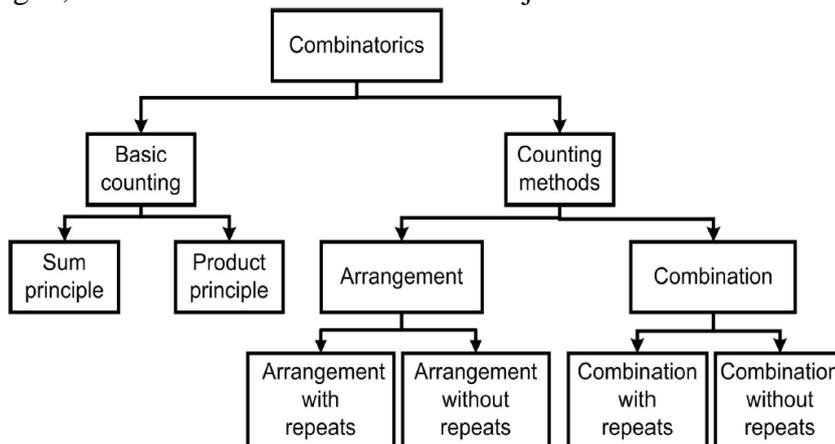


Figure 9: segment of the tree of concept for Discrete Mathematics discipline [20]

Social Network Analysis (SNA)

- The second study in this paper [20], interests with a number of effective loggings in the system, to that help the teacher to control the activity of pupils in the adaptive environment of e-learning. Measuring and analyzing the number of effective loggings in the system it considers under SNA.

Statistics

- The item response theory (IRT) are statistical models which permit researchers to show both the competence level of learners and the difficulty level of the exercises on the same continuum, but to more precisely, the Rasch model presents in the study [24]. The Rasch model

tests latent features such as attitude or ability; it shows the likelihood that a person will receive the correct answer on a test object.

Data mining:

•As we said before, several surveys have shown that methods could successfully and skillfully be integrated into an education area. It may be utilized to overcome problems of classification and prediction in the area of education. Fuzzy logic networks and artificial neural networks are the most common methods used to solve these problems. In this year, Mohammed and Ammar in [26] suggested hybrid process that gathers a fuzzy system with a convolutional neural network. The first model has been utilized to discover a facial expression of the learner and the second model is utilized to select the next scale of learning to depend on the elicited facial expression based on the CNN model. In the last study [27] the fuzzy logic was also applied to discover the learning style of student spontaneously.

Comparative Analysis

In this section, a general comparison among various case studies during (2018 - 2020). We have already explained different proposed approaches and classify those according techniques that have been used.

| Study No. & Year | Goal of study | Proposed approach | Methods & tools | results |
|------------------|---|--|--|---|
| 1 (2019) | to observe and boss the learner performance more effectively and saving time of learning | proposed a framework of Business intelligence for AE-LS | BI tools (ETL tool) | The study shows that student ordain little time on tutorials and courses and prefer to employ cooperative activities |
| 2 (2018) | to improve adaptive e-learning system, principles of its elaboration its structure and ingredients | Create and describe the unique structure of the adaptive system of web-based education | used poliparadigmal and The competenc e-based approaches | During the introduction of the adaptive e-learning course in the educational process, a range of benefits were disclosed to both teachers and students. A student questionnaire showed that the use of the AELC led to the creation of coherent discipline awareness, improved motivation to learn the course, and reduced psycho-emotional stress. |
| 3 (2018) | develop a platform of adaptive e-learning that promote skills from elementary school to high education learners | this study related to learners of primary-school utilizing the Implicit module of TACIT adaptive tool over the academic year (2016-2017) | IRT models(the Rasch model) | This study offer a first positive answer to the efficiency of adaptive tool. This effectiveness of pedagogical is clearer for low-level learners, mostly for girls and for older learners. |
| 4 | Focusing on the evaluation | The study proposed a model of electronic- | The evaluation | The suggested approach permits to select the personalized content for the learners, and then |



| | | | | |
|-----------|--|--|-------------------------------|---|
| (2019) | task that plays a deciding role in the process of the learning and addresses the relevance of this action for each process participant. | assessment for an adaptive educational system, this model provides two kinds of reports, which include beneficial feedbacks for instructors and learners. | implemented in LMS | the method to provide it according to their prediction and their styles of learning |
| 5 (2020) | modeling the environment of learning to generate appropriate learning objects according to facial expressions of learners and their emotional status | Authors suggested a hybrid method which consists of the use of a CNN and fuzzy-logic system. | A fuzzy logic system with CNN | The experimental results show that the suggested method offers adaptive learning flows that match the capabilities of learning of a group of learners. |
| 6 (2019) | designing an AES which automatically adapts to preferences of learner depending on the learner learning style | The authors introduce a classifier can identify and define the learner's learning style in the E-Learning | (FCM) algorithm | The proposed method shows its superiority compared with the state of the art; even while the data are collected from learners' learning behaviors corresponding to sundry courses wasn't enough. |
| 7 (2019) | To automatically define learning style based on the behavior on courses of E-Learning for a specific topic. | Study proposed a robust classifier to classify the learner's style in the E Learning System. The learning activity of the student is recorded in various contexts usually in different courses on a particular subject | Fuzzy CMeans (FCM) | The method is evaluated by conducting two experiments using two and three courses, respectively. The output of the C-means algorithm is employed by measuring the accuracy of the performed experiments. The outcome indicates that in both the two experiments, the FCM algorithm performs better. |
| 8 (2018) | Improve the learning impact, which is fundamentally applied to online learning. | This study proposed adaptive system for writing the foreign language. AES for foreign language writing attempts to match characteristics of learners' personality with learning object | The QSLA | The results indicate the effectiveness of this system in helping to write a foreign language |
| 9 (2020) | To explore the influence of the design | Designing the proposed online adaptive environment | MI theory | The findings showed that the adaptive e-learning environment contributed to the improvement of writing skills for EFL students and |

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| of an adaptive learning environment on the development of writing skills and usability of EFL undergraduates. | which used the multiple intelligences (MI) theory for performing the process of adaptation. | | the students considered a learning environment appropriate for communicating with fellows and teachers. |
|---|---|--|---|

All these studies approved the importance of an adaptive e-learning system and illustrated how to assist in developing the learning process in an adaptive environment. They used different tools to help to construct suitable approaches and models to reach their goals.

Challenges:

Designers of adaptive educational environments, including teachers and curriculum designers, aim to create a safe and comfortable learning environment for the student in which he learns in a way that suits his preparations and abilities without causing him embarrassment among his colleagues or with his teacher by breaking the template of social comparison of a student with other students, and enhancing the student's sense of what he has experiences and capabilities and compare himself with himself through the development of his performance to create a positive educational identity of his own. There are different challenges to building AES [30]:

- Making Adaptive E-learning Systems Scalable :

Nowadays every two years, the amount of available data doubles. This data growth is a significant fact that adaptive systems need to take into account since far more data will be available to use and forecast last years [30]. To be capable of dealing with this vast data, it is needful to scale the existing adaptive systems to more needing data volumes [30]. Our aim is to accelerate learning processes. Scaling techniques use hardware-based fundamentally on parallelization, mobile applications, cloud computing and fixed memory. [30]. To address this challenge:

- (1) The creation of new incremental algorithms and the transformation of current learning algorithms to work in the incremental online manner [30].
- (2) Develop techniques for algorithms of learning to work within modern hardware solutions: cloud computing and parallel processing [30].
- (3) Designing techniques capable of running algorithms for data mining on resource-aware devices such as PDAs, cell phones and sensors [30].
- (4) Building some algorithms which could return an approximation of the correct response based on the calculation quantity they could perform [30].

- Dealing With Factual Data:

Techniques for adaptation focus on typical adaptive learning algorithms. It is generally assumed that all data is pre-processed already or connected to forecasting algorithms where the input for adaptive driving is instantly available once each prediction has been made and as soon as new data arrives. Sometimes the actual parameters of the streaming data device are not as subtle. Therefore, We have to create some algorithms to process and learn from such real data in an automated manner [30].

- Developing Trust And Usability:

Adaptive systems are inherently parameterized. Generally, it is a hard to set and tune its parameters. This in turn adversely impacts the systems usability [31].

- Incorporating expert insights:

Most businesses on adaptive systems are interested with the matter of how to utilize learning machines in variable environments without considering the potential of merging knowledge offered by experts or demonstrating the behavior of systems utilizing interpretable rules [31]. There are also many challenges for this system, and these challenges addressed by different ways. With the emergence of modern technologies and development, new challenges will increase.

Conclusion and future work:

E-learning system currently concentrates on learning channels where learner aspirations, encouragement, modes of learning, behaviors and needs are taken ever more into account. AES can be defined as an e-learning system which provides learning materials according to individual differences per each learner. This system had three basic models: learner model, adaption model and domain model; these models work with each other to provide adaptive learning content.

Some technologies and tools contribute to enhance the adaptivity in e-learning such as Artificial intelligence which helps develop skills and testing systems and offer Smart Content for learners. Also, some statistics tools are used to implement reporting and offer basal statistics of interactions of learners and system of e-learning. Some technologies like data mining used to solve classification process and prediction problems in education.

This paper introduced some studies that illustrate the importance of adaptive learning and how this system helps learners in learning process through generating a suitable learning path according to their interest and their learning background. This system helps to enhance reading and improve writing skill like what presented in the last study in this paper. As any system, AES faced some challenges like realistic data dealing, developing trust and usability and making this system scalable.

In the days of the covid-19 pandemic, traditional learning has turned to electronic one, and this will encourage researchers to search and enhance the work in this field of e-learning. Next work will be search how to make the adaptive system of e-learning cooperate with other ones in different country to take advantage of positive experiences in the process of education, which may improve the efficiency of learning.

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