International Journal of Computing and Business Research (IJCBR)
ISSN (Online) : 2229-6166
International Manuscript ID : 22296166V11I2202105
Volume 11 Issue 2 March 2021

Design and implementation an adaptive-intelligent website based E-learning for higher Education

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Abstract-The spread of technology and the Internet has an important role in people's dependence on e-learning. This has been proven by the current situation of the spread of the Covid-19 epidemic. Which forced all educational institutions to close their doors and the trend of e-learning in order that the continuity of education in the absence of current circumstances. In this paper, an interactive and smart website is designed to be used for e-learning in higher education. The process of designing this website was done using the Instructional Design Model ADDIE. The site contains many pages that contain educational tools and tests. And tests have an important role in assessing the educational levels of learners. And that one of the best types of electronic tests is MCQs. The process of creating MCQs takes a lot of time, focus and effort. Therefore, we designed intelligent and advanced algorithms that can generate MCQs automatically

Index Terms- adaptive-intelligent website, e-learning, automatic MCQs generator, higher education, website management, ADDIE

I.INTRODUCTION

The development of technology in our time is a very important role in our life. Which led to the employment of technology in all areas of life, such as education, entertainment, industry, etc. The modern digital revolution was distinguished by cooperation between traditional methods of coexistence with modern technology methods, in order to facilitate people's lives [1]. Also, this technological revolution has an important role in changing the way of education in universities. Educational technology has had a great impact on increasing levels of learning, by using modern teaching methods in universities [2].

The primary goal behind using technology in education is to facilitate the learning process for learners. All types of learning that are integrated with technology is called e-learning, which refers to the digital learning environment or the computer learning environment, which mainly focuses on communicating information to the learners [3].

Higher education has the primary role in spreading science and culture to societies through universities, in order to educate the younger generation to learn and facilitate all learning

methods in order to help them develop their knowledge and experiences in societies. This leads to the importance of using e-learning in higher education in order to create an appropriate educational environment for students in universities [4].

Due to the technological advancements in our time. All educational institutions must direct their attention to e-learning, to meet the needs of millennial generations. As is evident in our recent times, the common feature of all millennial generations has overwhelmed their ability to adapt to modern electronic equipment and use new technologies such as smartphones, tablets, or computers, etc. So, they are very passionate about using technology. Therefore, it is our duty to provide them with education that is integrated with technology [5]. Based on the importance of education, we must provide education in any place and at any time by designing websites that are used for the education of students in higher education. Without reducing the normal learning process by filming lectures and publishing them in the form of videos on the educational website [6].

E-learning requires a set of assessments for students to clarify their learning levels. And these assessments must be compatible with the modern aspects of e-learning, that is, there must be electronic tests through which the student tests himself. Many e-learning sites use multiple-choice question (MCQs) tests, which are considered tools for assessing learners. The MCQs consists of a short question in addition to four choices as answers, one of them is correct and the other three are false, it is used as a distraction [7].

MCQs take a lot of effort and precision at work in order to create them in addition to the time they take [8,9].

Therefore, this proposed research focuses on designing algorithms that work with artificial intelligence in order to create MCQs automatically, without the need for any data by the administrator of the e-learning website.

II. RESEARCH MOTIVATION

We notice at the present time all educational institutions in higher education are moving towards e-learning. This is due to the current conditions of the spread of the Covid-19 epidemic, due to which all schools and universities have been closed for health reasons in order to preserve the safety of students. This required educational institutions to experience e-learning through some e-learning platforms. The proposed work aims to design an electronic learning website to be used in educational institutions in higher education. By making electronic lectures in the form of videos that are used by students to help in the learning process. In addition to developing a test system based on artificial intelligence.

III. RELATED WORK

This research was done on the basis of reviewing several previous researches in various fields related to e-learning such as designing e-learning platforms and designing multiple choice tests in addition to research related to designing automatic question generator algorithms. These studies will be explained as follows:

- **YuniSusanti, Takenobu Tokunaga and Hitoshi Nishikawa in 2020[10],** They have conducted a study on the possibility of developing automatic question generator from text

algorithms and integrating them with computer adaptation in order to develop automatic question generator systems that can form a question from itself and not rely on texts or topics previously added to the system. This is in order to obtain smart systems that operate at the lowest cost and effort, in addition to reducing time.

- **Pedro Álvarez and Sandra Baldassarri in 2018[11],** They designed a service-oriented system that automatically generates multiple-choice questions. The working mechanism stipulates the teacher to choose the topic from which he wants the question to be made, then the system relies on the teacher's input topic to make the questions and present them to the teacher, and while it's approved, put these MCQ in Google Form and sent to the students.
- **Karen Mazidi and Paul Tarau in 2016[12],** They introduced a system that generates the subjective question by understanding the required meaning in a sentence from the context of speech. Relying on intelligent evolutionary algorithms. These algorithms work by converting natural language understanding into natural language generation. The question is prepared in two parts, the first is to analyze the important fundamentals of the sentence, while the second part is the way to make questionnaires that fit each sentence. The success rate of generating the correct questions in this proposed system is 55%.
- **HimanshuJethwani, MohdShahid Husain and Mohd Akbar in 2015[13],** They developed Automatic Question Generation from Text This system only creates factual questions. The system relies on the text entered by the user in order to generate questions. The results of this proposed work are explained. The number of sentences in the entered text is 12 and the number of questions generated by the system is 21. As for the questions proposed by humans on the same text, it is 23. Hence, the accuracy of the proposed work is 91%.
- **MuktaMajumder and Sujan Kumar Saha in 2015[14],** They introduced a system that generates questions automatically. The way this system works depends mainly on the text entered by the user. The first step in the work of the system is to determine the important sentences that contain valuable information from the entered text, by relying on some of the terms in the language dictionary, which is one of the basic parts to learn the algorithms used in the proposed system. The second step is the method of placing the important information suggested in the previous step in the context of a sentence indicating a question. The accuracy rate for this proposed system is 93%.

IV. RESEARCH OBJECTIVES

The objectives of this research are:

1. Designing a website to be used for e-learning to help higher education students.
2. The design mechanism depends on the proposed website being multi-use. The meaning of the possibility of setting up the proposed website to serve all areas of education, in order to meet the wishes of the website administrator.
3. Ease of using the capabilities of the proposed website, due to the use of the adaptive environment in designing the proposed website.

4. By relying on the artificial intelligence mechanisms built into the proposed website, the goal of reducing the effort and time that the website administrator has to work with has been reached. This is by developing algorithms that can create self-questions to test students without returning to the website administrator.
5. Provide two types of protection for the website from hacking. The first is to use the hash Function to encrypt users' passwords in the database. The second type is using googlerecaptcha in order to distinguish between human and malware that may threaten to disable the website's server.
6. Implementation of the proposed website on a public Internet server. This is in order for it to be available to all users in any place or any time.

V. AUTOMATIC MCQs GENERATOR

This thesis has a specific goal, which is to integrate artificial intelligence into e-learning. This is in order to create a smart learning environment that provides the learner with an enjoyable and smart experience. The artificial intelligence mechanism built into this website is how to create a self-questioning from the website using the Internet to test the capabilities of the learner in general and is useful. The question that is generated on this website is in the form of multiple-choice questions. This website mainly relies on the Wikipedia site as a repository for information that extracts questions from articles available on Wikipedia. The mechanism of action starts as follows, when the learner wants to test himself, he enters the title of the specified topic in the mind of the learner, and then the website searches within Wikipedia articles on the title of an article close to the required topic and stores it temporarily and after that he divides the article into sentences. Then comes the process of processing the sentences to extract the question and make correct and wrong answers, and by using natural language processing we define important things in the sentence such as names, times, or places. Using some simple grammar in the language, the question is generated. As in the following algorithm (1).

This proposed work has three stages in order to complete the process. The first is the preparation and training stage. The second is the question generation stage. The third is correct and wrong answers generation stage.

Algorithm 1: automatic multiple-choice question generator AMCQG

Algorithm: AMCQG
Input: subject title
Output: Question, Correct answers and Wrong answers
Start
Step 1: import Wikipedia, NLTK, flask and requests from python library
Step 2: create connection between our website and Wikipedia website byusing flask and requests
Step 3: fetch the article form Wikipedia website server that match the subject title by using Wikipedia tool kit we mention it at step 1
Step 4: spelt article into sentence according to each sentence must be end with (.)
Step 5: store the sentences temporarily
Step 6: train the algorithm according to simple grammar
Step 7: generate question
Step 8: generate correct and wrong answers
Step 9: preview the question and the answers to the user
Stop

1.Preparation and training stage

In the training phase there are many steps that will be executed sequentially. At the beginning of the process, the sentences that were prepared in the previous stage are loaded. Then, important sentences are determined that contain names, places, addresses, times, numbers, or dates. This is done by detecting and recognizing parts of speech using natural language processing algorithms. Then the tree object building process takes place. Then the unwanted phrases, punctuation, or parentheses are eliminated. And this process is done according to the following algorithm (2).

Algorithm 2: Preparation and training data set PTDS

Algorithm: PTDS
Input: sentence
Output: part of speech that belong to sentence and training data set
Start
Step 1: load sentence from previous stage
Step 2: detect topically important sentence
Step 3: mark names, places, location, time or dates which can be potential gap candidates
Step 4: detect and recognize different part of speech by using NLTK tagging Feature
Step 5: construct tree object
Step 6: eliminate unwanted phrases, punctuation and parentheses
Step 7: training data set
Step 8: store part of speech template temporarily for next stage
Stop

1.1 Creation of Tree object

When the sentence is loaded, it will be divided according to the parsing positions for each word in it. And according to different categories such as a noun, verb, adverb or pronoun. On this basis, the gap that could be a question is chosen.
For example, take the following sentence “Windows Defender isolate computer component from internet allowing some data to pass, blocking others”Now take a look at the next figure (1).

Purpose	Expression
To define the main verb in the sentence we use:	ROOT < (S=clause < (VP=mainvp [< (/VB.?/=tensed !<is|was|were|am|are|has|have|had|do|does|did) | < /VB.?/=tensed !< VP]))
To define the main noun in the sentence we use:	ROOT=root < (S=clause < /(MD|VB.?)/=aux < (VP < /VB.?/=verb)))

After building a tree object. The proposed work relies on a specific expression to identify and define the verb or noun in the sentence. The following table (1) shows us how to determine the noun or verb in the sentence. Which can help locate the gap in a future step.

Table1: An example of expression used

```
($ (NP Windows Defender)
    (VP isolates
        (NP (NP computer) component)
        (PP from
            (NP internet
                (VP, allowing
                    (NP some data)
                    ($ (VP to
                            (VP pass)
                            ,
                            ($ (VP blocking
 (NP others)))))
                    .)))))
```

Figure 1: Constituent Tree object for the sentence

1.2 Training the algorithm

After completing the sentence processing stage, detailing it into parts of speech, and identifying the noun or main verb of the sentence in the previous stages. Now we come to training the algorithm in some simple grammar. Which, through this training, allows the algorithm to know and determine dates, numbers, locations, etc. And then training to choose the correct spot gap. And how to remove the appropriate word and put it as a gap. The following table (2) shows the formula of some simple rules that are used to train the algorithm.

Purpose	Expression
NUMBER	{<$>*<CD>+<NN>*}
LOCATION	{<IN><NNP>+<,|IN><NNP>+}
DATE	{<IN>(<$>*<CD>+<NN>*)}
PROPER	{<NNP|NNPS><NNP|NNPS>+}
HIT	{<PROPER><NN>?<VBZ|VBN>+}

Table2: Example on simple grammar

2. Question generation stage

The multiple-choice questions are one of the most common types of questions common to learners as they are easy to answer and thus depend on the comprehensiveness in which the topic is chosen. The benefit of this stage is to prepare the question that will be presented to the user. Initially when an array of speech fragments that were prohibited in the sentence preparation stage is loaded. In addition to loading the potential gap location through the algorithm training process.

The gap is now addressed by excluding stop words from being a gap, and by giving importance to names, numbers or places so that they are an expected gap. Then the matrix of parts of speech is returned to the original words in the input sentence, taking into account the process of converting the expected gap into a blank. As in the following algorithm (3), which will explain this process in simpler terms.

Algorithm 3: Question generator algorithm QGA

Algorithm: QGA
Input: part of speech array
Output: question
Start
Step 1: train the algorithm with predefined the gap
Step 2: preprocessing the potential gap
Step 3: eliminate stop word from being a gap
Step 4: give priority to name, number or place
Step 5: convert the potential gap in the part of speech array into the original word and store it in the write answer pool for using in the next stage
Step 6: replace the potential gap with "_____"
Step 7: convert the part of speech array into the original sentence and ignore the potential gap to create the question
Step 8: view the question to the user
Stop

3. Correct and wrong answers generation stage

After the process is completed, the question is formed and the correct answer is stored. Now comes the stage of preparing the intentional answers, the condition that one is correct and two wrong. We give an instruction to the question generator algorithm by making 10 more questions from 10 other sentences and preparing their correct answers. Now we are matching the parts of speech for the correct answer in the current question with the parts of speech of the other newly generated correct answers. If there is a match, two answers will be randomly taken and added to the wrong pool for the current question. Then the wrong and correct answers are presented to the user in a random sequence. As we will explain in the following algorithm (4).

Algorithm 4: Correct and wrong answers generation CWAG

Algorithm: CWAG
Input: question
Output: answer
Start
Step 1: fetch correct answer form correct answer pool that has been prepared in the previous stage
Step 2: make request to generates 10 question and correct answer from 10 next sentence
Step 3: matching the correct answer part of speech with the newly generated correct answer
Step 4: take random 2 correct answer from other question
Step 5: store them in wrong answer pool for current question
Step 6: collect answers form correct and wrong pools
Step 7: view it to the user in random sequential
Stop

International Journal of Computing and Business Research (IJCBR)
ISSN (Online) : 2229-6166
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Volume 11 Issue 2 March 2021

VI. WEBSITE MANAGEMENT

In the Website Management, the pagesof the website that serves theadministrator, studentand the visitor is being designed. It depends on the fivephases of the ADDIE model which are the (analysis, design,development, implementation, and evaluation). Theseessential phases are illustrated as follow:

A. Analysis Phase

The first phase of ADDIE model is the phase of analysis through which the analysis process for designing and building the proposed website will be clarified. Which will come to two plans as follows:

- **First plane:** Some of the requirements and needs of learners were gathered by knowing their opinions on e-learning. This process was carried out using the Google Form questionnaire and published it in the Facebook groups for e-learning. This process took place before the start of the website design process, in order to benefit from the opinions of learners and apply their observations in building the proposed website.
- **Second plane:** Many articles and scientific papers related to e-learning have been viewed. The results they reached were taken into consideration and used in building the proposed e-learning website.

B. Design Phase

The second phase of ADDIE model is the phase of designing. During this phase, the design process of the website's pages is clarified. The program "IPLOTZ" was used. In order to design and models' non-interactive interfaces in order to clarify the design process before starting programming the website pages.

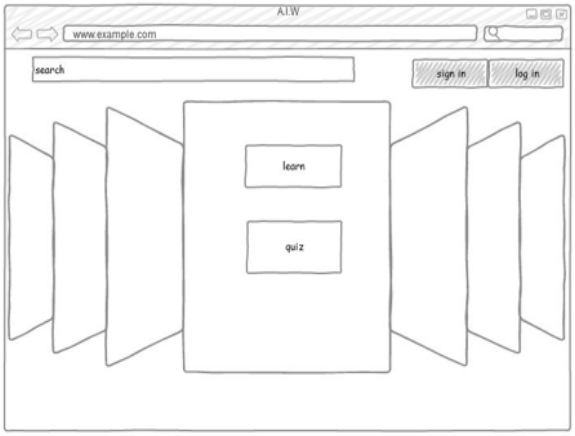

Figure 2: welcome page prototype

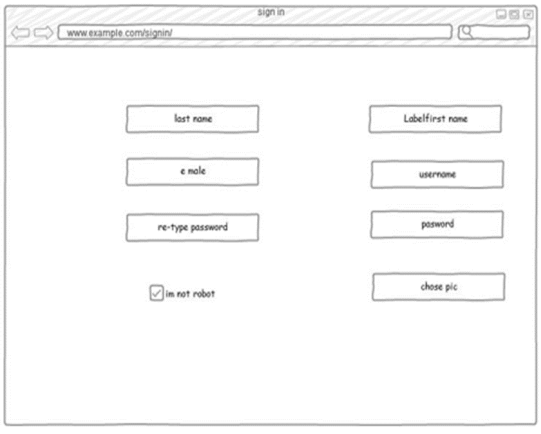

Figure 3: sign in page prototype

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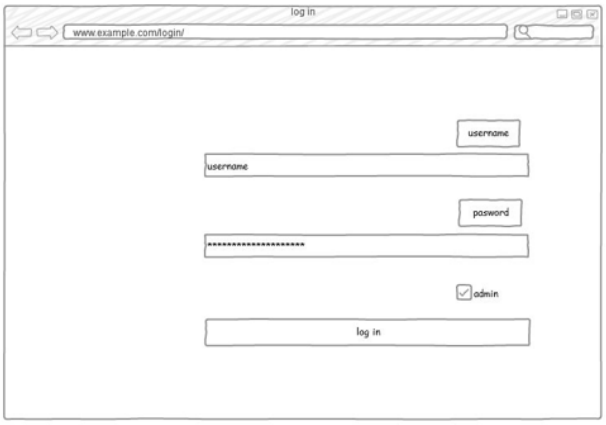

Figure 4: log in page prototype

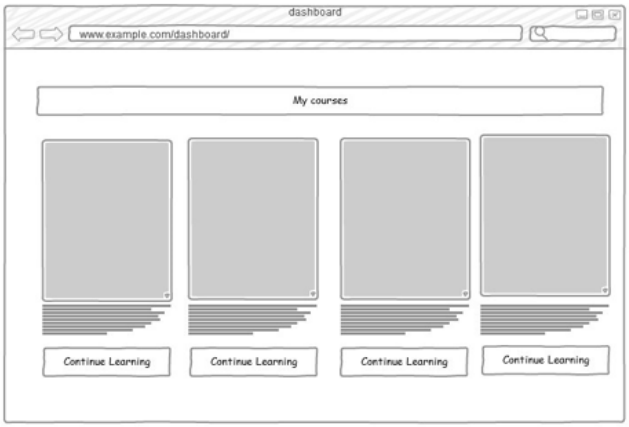

Figure 5: dashboard page prototype

C. Development Phase

At this phase, a website plan is implemented. In addition to choosing the programming languages that are suitable for work in the proposed website, as mentioned in the second chapter. In addition to clarifying user functions. The development phase is divided into two parts.

1.Development Architecture

In this part, it will be explained how the proposed website works. And how does the user access the information provided by the website? What are the programming languages that fit the design of this proposed website? All this will be illustrated in the following Figure (6).

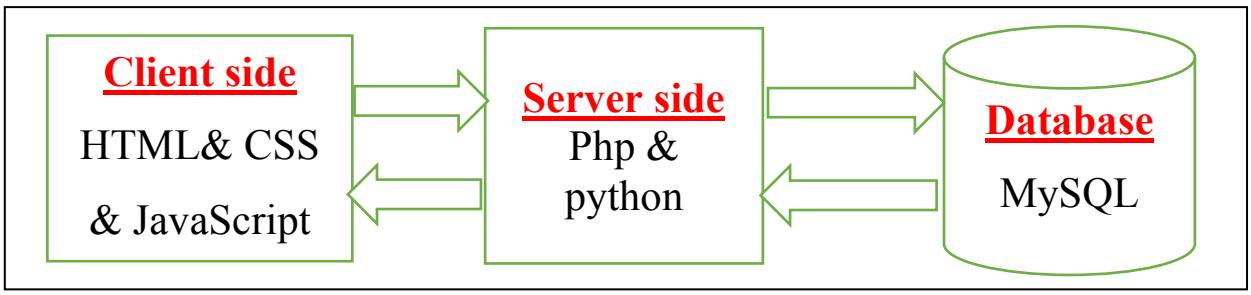

Figure 6: Architecture of the website

2.User Functionality

Throughout this part, the privileges and functions of the users of the proposed website are clarified. And through the following illustration table (3). Where the user ability is represented by the word true. And the inability of the user is represented by the word false.

Permission	Visitor	Learner	admin
View website contents	True	True	True
Experience quiz	True	True	True
View lesson details	True	True	True
Enter the lesson	False	True	True
Upload and Edit lessons	False	False	True

Table3: User Permissions

D. Implementation Phase

At this phase, the basic files for the proposed website are transferred from the local web server to a public web server. This is in order to direct some users to try the website. Taking into consideration the comments they provide. In addition to solving the problems they faced.

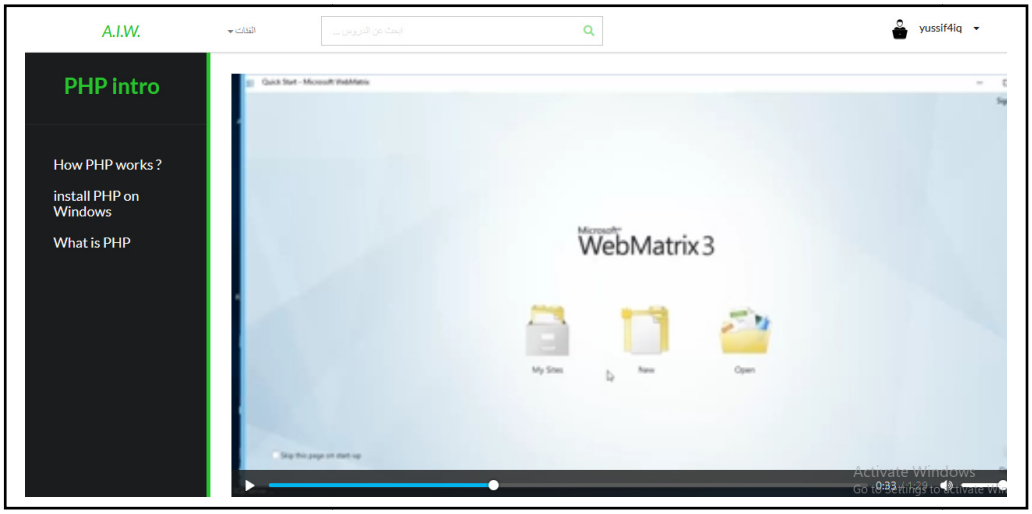

Figure 7: Course display page

Figure 8: details Courses page

Figure 9: Quiz page

Figure 10: quiz about date

E. Evaluation Phase

This evaluation was done on the basis of calculating the question generation capacity by the intelligent question generation algorithm that embedded into the proposed website.

We have selected 90 of the most read articles on the Wikipedia website, specializing in Computer Science. Then we read them all and locate the expected gaps in each article. Then we requested the questions form our proposed website that related to each article title. The results will be shown in the following table (4).

	No. of article	No. of sentence	No. of expected gaps	No. of generated questions
Total	90	962	2027	1923

Table4: Question generation evaluation result

VII. CONCLUSION

This paper presents a method for designing a smart and adaptive website that is used for e-learning in higher education. Where this study focuses on website design and preparation of the lessons that study it. This website relies on a mechanism for designing automatic tests. In order to test students' abilities.Taking into account the different choice of expected gaps from one person to another. In addition to the strength of the Internet connection. The question generation algorithm built into the proposed website depends entirely on fetching articles from the Internet. Therefore, the proposed website needs a strong internet connection in order to operate with high efficiency. The accuracy of automatic MCQs generator algorithm is 94.8%.

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