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Continuous Acquisition Of Basic Engineering Attributes While Studying Engineering At Universities

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Abstract

This paper aimed to improve engineering learning process in the international universities. By reviewing a lot of researches, there is a weakness in the engineer's preservation of basic engineering skills and the continuity in following up recent developments. This study relied on the description of the attributes required by the engineer and the adaptive education systems to provide a viable model to raise the level of competence of the engineer and to maintain his cumulative possession of skills. The study determined the adaptive educational capabilities available in some educational systems that serve the desired goal, and then expand some of those capabilities to raise the level of education. In addition to add some unavailable components whose importance appeared during the study.

Keywords: Adaptive, Domain, student, style

Introduction

Adaptıve Learnıng

Adaptive learning has been defined as education that takes into account individual differences among learners. These differences relate to more than one direction: differences in the achievement of previous learning objects, differences in personal characteristics, and differences in preferred learning style. Learners in traditional education access the same learning content through the internet, regardless of the individual learner's profile. While learners may have very different educational backgrounds, as well as knowledge levels, learning styles, and abilities [1]. Personal user profiles may contain all the information about the user that the educational system will rely on to manage the adaptation process. The content domain model is very necessary in order for the system to be able to be sequenced into the learning units assigned to the student. The adaptive system will link the learner's profile and the content domain model to create adaptive learning content that matches the characteristics of the learner, thus raising the level of his ability to receive the learning material [2].

Engineering Education

The study of engineering is one of the most difficult studies that needs a strong connection between the concepts previously studied and those currently being studied. An engineering student needs a high percentage of engineering skill concepts because engineering education is a cumulative and not a discrete process. Engineering, in all its branches, depends on an applied education and based on the accumulation of skills. The abilities and personal attributes of the learner may be an obstacle to his educational attainment, which is necessary to achieve to be an expert engineer in his work. Accordingly, adaptive

education is a very necessary approach to be followed in engineering education to ensure the highest degrees of educational attainment and applied experience [3].

This paper provides a model to ensure that engineering student receives the required learning objects in addition to the skills that enable him to excel and compete in the labor market after graduation.

Theoritical Framework

The reality of studying engineering in the world

Education is of great importance in societies and countries, so it is considered as a form of investment that is spent on to get future benefits. The strength of any nation depends mainly on the number of skills available in it and its technical level. Education is an essential element for achieving sustainability in development [4]. Fresh graduates make lower achievements in competence and excellence, as well as keep up with competition around the world. Fresh graduates need to adapt to new skills in the global market to remain able to stand out in the market. The world has a new working condition and a new working environment. The key element for graduates to stay close to these new conditions is to be aware of the new requirements in the labor market (Baker 1975).

Engineering Characteristics Required by EAC (Source: EAC Manual 2006):

1) The ability to acquire and apply knowledge of the basics of science and engineering
2) The ability to communicate effectively, not only with engineers but also with society as a whole.
3) In-depth technical competence in a particular engineering discipline.
4) The ability to identify, formulate and solve a problem
5) The ability to use a systematic approach to design and evaluate operational performance.
6) Understand the principles of sustainable design and development.
7) Understand and abide by professional and ethical responsibilities.
8) The ability to work effectively as an individual and in a group with the ability to be a leader or manager as well as an effective team member.
9) Understand the social, cultural, global and environmental responsibilities of the professional engineer, and the need for sustainable development.
10) Anticipate the need to undertake lifelong learning, and possess/gain the ability to do so.

Universities still follow the traditional method of lecturing regardless of the number of students in the class. Whether the number of students in the class, ten or a hundred, this leads the students to an end-to-end directed instructional style without giving the students enough opportunities to interact with each other. There is no doubt that traditional lectures are effective, and this means of imparting knowledge to a large number of students at the same time, but the measure of how much students absorb remains in question. [5, 6, 7]. It used to be one of the few ways for students to learn, but the world is a different place now, especially with the wide availability of online information, which is available almost everywhere [8]. Technology plays an important role in expanding educational spaces, especially active ones, and this raises the possibility of devising new ways and methodologies in learning that solve previous problems [9].

Need for adaptive learning and student learning style

Through many studies that have been conducted, there is a clear conflict between the teacher's style and the learner's preferred learning style in studying engineering, and this explains the failure of many students in studying engineering despite being among the top achievers in the school stages [10]. Certainly, the study of engineering cannot be dispensed from the traditional method of teaching through regular classes, but the study of engineering also needs educational methodologies that are considered as supportive and complementary to the traditional education. One of those methods is adaptive education, which deals with many problems that students suffer from. For example, it addresses the problem of differences in learning styles among students, including sensory, intuitive, visual, auditory, inductive, deductive, active, and adaptive learning which provide learning paths to individual students [11].

The student's preferred educational or learning style is not the only component that requires adaptability, but it is the essential component of it. In order to obtain the preferred learning style for the student, figure 1 shows all types of learning styles [12].

Figure 1. Dimensions of Education and Learning Styles

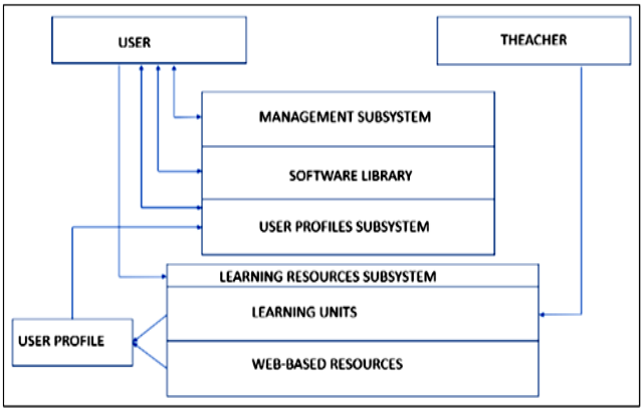
Preferred Learning Style		*Corresponding Teaching Style*	
sensory / intuitive	perception	concrete / abstract	content
visual / auditory	input	visual / verbal	presentation
inductive / deductive	organization	inductive / deductive	organization
active / reflective	processing	active / passive	student participation
sequential / global	understanding	sequential / global	perspective

Adaptive learning methodology

SALM

Adaptive education is an effective solution to the problems of higher education [13]. There is no doubt that modern technology and the internet have created new dimensions to adaptive learning. Several investigations are being conducted on the use of adaptive learning in the higher education environment [14]. Many educational platforms have adopted adaptive education as a technical approach. For example, the intelligent adaptive learning model (SALM) is an adaptive learning model. It is the result of an ongoing research being conducted within the DocTDLL project, funded by the Latvian Science Council. The SALM model provides customized education to groups of people through timely feedback, pathways and resources. The primary objective of SALM is to quickly and accurately determine what a student knows and does not know in a learning context. The SALM algorithm is shown in figure 2 [15].

Figure 2. SALM Functional Structure



The SALM methodology is matching among learners. The smart agent keeps track of the educational paths and resources visited by a learner and then searches for similar profiles of other learners and suggests the same path to them. The assumption is that the effective learning path can be dynamically generated and suggested to learners with a similar profile.

The learning status is made and progressed by the learning unit and the learning achievement is expressed by five points (poor, fair, good, very good, excellent), and interpreted by another intelligent agent.

Ontology is automatically generated to organize online learning resources, as well as to predict what knowledge a user should learn next, while another agent provides personalized access to learning resources. The proactive algorithm provides assistance to users who are facing difficulties in achieving a particular learning object. This is based on evidence that the learner needs to internalize certain concepts or perform specific exercises in order to enhance his or her achievements. In fact, Bayes' theorem describes the probability of an event occurring, based on prior knowledge of the conditions that may be related to the event.

As a result, SALM operates within four resources: learner profiles, competency-based achievements, personalized learning, and a flexible smart learning environment [16].

AVCM

AVCM was proposed by researchers to find a certain methodology in building adaptive learning, a system that supports adaptive e-learning and adheres to the basic lines defined by researchers in adaptive learning. The system proposed by them works according to the cognitive style of the student that is saved and updated dynamically in the student profile. The model suggested three types of student study styles, which are the basic styles, visual, listener and textual, they were represented by the group <ver, vis, and lis>. The proposed system relied in its methodology on three operational elements, namely the student model, which contains the student's profile in addition to other characteristics that relate to the student and affect his educational path. It also relied on the domain model where the sequence of LOs and other activities are organized in the form of a tree. Visit the course content starting from the class to the smallest concept.

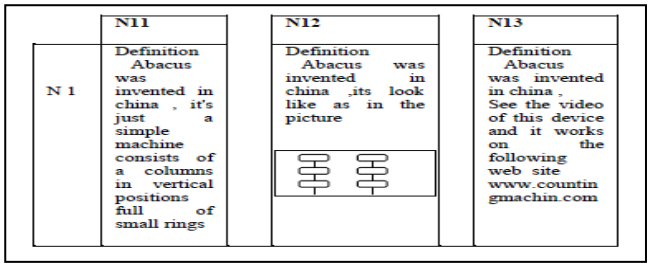
The system receives at the beginning of the student's preferred learning style through a questionnaire that the learner fills out, and this is the default value of the student's learning style. Then the system uses machine learning to deduce the student's preferred learning style more accurately through the cumulative conclusion during the student's sequence in studying the educational course. With the student's completion of any study concept (LO), he is automatically subjected to a short test to measure the student's understanding of that concept. Through the student's profile, his stored learning style is obtained

and a short exam is presented using that pattern. If the student answers the question correctly, this increases the accuracy of the student's learning style, and if his answer is wrong, the system automatically re-asks the question in another learning style, and if the wrong answer is repeated, it continues to display the question in other patterns. In the event that all the patterns are finished, the system assumes that the student has not achieved enough in studying the concept, so it returns it to the concept again to study it with changing the learning style with a new pattern. The process continues cumulatively with each concept, then the unit, then the entire course, and within a cumulative case, the system's evaluation of the student's preferred learning style increases.

The test process is drawn from the Petri Net (Status/Event) model to determine the next step after the student's response. Based on the test results, it serves for two purposes, the first is to assess the student's knowledge academically, and the second is to provide information to the student's profile, and this information along with other information as shown in [11] will work on adaptive learning and other systems that need information about the student such as the adaptive discussion room [17].

The following figure 3 gives a model for one of the questions from three different ways to be presented to the student and contribute to determining his learning style.

Figure 3. A model for One of the Question Styles



Standard Adaptive Methodology for Applied Engineering Learning

Discussion

With reference to what was previously explained about the nature of studying engineering and the problems it suffers from and the need to excel in the student's cumulative skills it appears clearly that studying engineering, as discussed previously, depends on mastering cumulative skills to achieve continuity. This mainly involves the engineer staying close to the newly invented skills and techniques because the lasting competitive advantage mainly depends on this activity.

Referring to the required attributes of an engineer, we can summarize them in: Possession of basic engineer skills, specialist in an engineering field, understanding and solving problems, designing and building systems, responsibility, individual and team work, continuity of learning. All these concepts, the educational system, whether in the university or in training, must take into account that the engineer has to master these attributes.

When discussing traditional education, the engineering student moves from one level to another by taking the tests that qualify him to advance. But this education does not guarantee that the engineering student will continue to possess the aforementioned attributes continuously and cumulatively. This requires improvements in the educational systems to achieve this goal. Through this, the role of adaptive education in educational systems for engineers is clarified as the following:

1) Ensuring that the engineer maintains the required attributes and their continuity

2) Ensure that the personal traits of the engineering student are taken into account during the educational process.

3) Ensuring that the student's preferred learning style is taken into account and providing the educational learning objects that fits this style.

4) Ensure that the student does not move from one educational level to another after verifying his achievement in the previous level.

5) Provides a mechanism so that students can interact and get benefit from their experiences among themselves.

6) Existence of mechanisms for evaluating all student activities in adaptive education, including discussions among them.

The previous six points will be discussed to check if they are available in the previously discussed systems, SALM and AVCM.

Regarding the first point, it is available in the SALM system, but it is limited in the sequence of learning objects in the course. It does not include other attributes. And in the AVCM system, it is also not available in the form that we are looking for. Accordingly, these systems need to add modules dealing with this part to ensure that the engineer continues to have the required engineering attributes. Regarding the second point, I don't see any system that has this technology. The feature of age, vision or hearing are not considered in these systems. Therefore, a detailed study of the student's personal traits should be conducted to create a unit can be carried out to take these traits into account in the education process. Regarding the third point, the AVCM methodology addressed this problem dynamically and found a solution for stylistic measurement using machine learning. As for SALM, there was no such feature. In engineering education, there may be a need to use more than the main learning styles that have been used in the AVCM and to extend that with the same mechanism by relying on figure 2. This ensures better delivery of didactic skills. Regarding the fourth point, both methodologies take this requirement into account, although it is better in AVCM than SALM. As for what was mentioned in the fifth and sixth points, the AVCM system has a creative model in adaptive discussion rooms, and it also provides a method for evaluating the written text among students from a scientific point of view as well as in terms of using time. This is not found in any other educational system.

Proposed Solution

So far, we have discussed forms of adaptation in engineering, close to the available space. In the previous

section, we discussed what is present and what is not in the systems. It is clear from the AVCM methodology that many of the adaptive requirements discussed are available, but need the following additions:

1. Expanding the learning styles with the same mechanism used to include the rest of the styles. This will require the development of the database to include more styles of learning objects.

2. Develop AVCM to include the mechanism used in SALM to raise the level of ensuring that the student meets the requirements.

3. Using the AVCM methodology in delivering the learning objects.

4. Using the AVCM methodology to determine the student's preferred learning style in a dynamic manner.

5. Using the AVCM methodology for educational chat rooms and student assessment during them.
6. Developing the AVCM and adding a new module to solve the problem of the continuity of the engineering student in achieving the required engineering attributes in order to keep the student in touch with the required attributes.

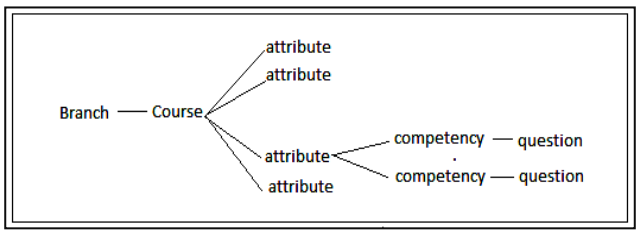
This module will be called "Attribute Model". This model will contain a database of tables that teachers can fill out. For each course the teacher must fill in the engineering branch and the attributes mentioned above, and for each attribute the teacher must identify the competencies required to achieve the attribute.

Table 1: Sample of Database Used of Engineer Attributes

[Table 1] shows the proposed database model sample. Br. No	Course No	Attribute No	Attribute	Competencies
1	1	1	Ability to acquire and apply knowledge of science and engineering fundamentals	1.check if the student can perform task 1 2. check if the student can perform task
	1	2	Ability to communicate effectively, not only with engineers but also with the community at large.	. . .
	1	3	……..	…….
	1	4	……..	…….

We can see in figure 4 the evaluation flow of engineer attributes.

Figure 4. Engineering Attributes Evaluation Structure



Through the table and figure above, the new addition became clear. As each of the attributes has a set of competencies that the student must achieve, and this is done through a set of questions that are asked to him upon completion of a course. For each question there is an assessment of the answer so that the student gets an assessment of the engineering attributes separately from his assessment in the course. This

process is repeated during the period of studying engineering, which ensures that the educational system keeps the student within the required engineering characteristics.

Attribute's module should be added to AVCM for each course and an agent should perform this activity, accumulative evaluation for each course will lead to final evaluation just before the graduation. During the next study, the process of expanding the use of learning styles in AVCM, including those mentioned, will be explained.

Conclusion

This study was conducted to find the best ways to improve engineering education. Through the previous section, it was found that engineering education can be improved by applying the engineering concepts available in the AVCM methodology, but this is not sufficient at the current stage. There are many mechanisms that must be developed or added to that methodology, the most important of which is to ensure the continuity of the engineer in possessing the required engineering characteristics. A solution has been found that guarantees the realization of this mechanism. The study also found that the concept of adaptiveness, depending on the characteristics of the user, which are insufficient and some of them are not available, which calls for adding and expanding other mechanisms to achieve this end. The study found that the mechanism used in the SALM methodology is very useful in raising the level of efficiency, which calls for its incorporation into the AVCM methodology. The evaluation mechanism and the adaptive chatting mechanism are a viable and useful feature to achieve the goal.

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