تطوير بيئة تعليمية لمادة الفيزياء في الحركة الدائرية والدورانية باستخدام النمذجة السلوكية الكائنية

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المستخلص

يهدف هذا البحث لتطوير بيئة تفاعلية لأحد المواضيع المختارة في مادة الفيزياء لطلاب المدارس الثانوية العراقية، والذي يركز على موضوع الحركة الدائرية والدورانية. أن اهم التحديات التي تواجه الطلاب تكمن في تذكر القوانين والقواعد المناسبة لحل المسألة وكذلك في كيفية تقليل صعوبة تطبيقها في الحل خطوة بخطوة.

لقد قمنا بتطوير نظام LECRM وهو بيئة تعليمية تفاعلية لدعم تدريس موضوع الحركة الدورانية والدائرية والذي يشتمل على اداة تأليف يستخدمها المدرس من ناحية، وأداة استعراض تفاعلية يستخدمها الطالب من ناحية اخرى.

في مراحل التصميم المختلفة لتطوير نظام LECRM، استخدمنا لغة النمذجة الموحدة UML والتي تدعم مفاهيم التصميم الحديثة مثل النمذجة واعادة الاستخدام. وقد استخدمت لغة UML في وضع النماذج المفهومية والسلوكية لكائنات واصناف النظام. يمتاز هذا النظام بانه يمتلك اداة استنتاج يستخدمها الطالب لانتاج واستعراض الخطوات المفصلة لحل المسألة. لقد تم بناء النظام باستخدام مزود تطبيقات الويب wamp ولغة قواعد البيانات MySQL ولغة PHP لتصميم الواجهات، وقد تم فحص النظام في احدى المدارس الثانوية المحلية من قبل المدرسين والطلبة.

الكلمات المفتاحية: هندسة البرمجيات، هندسة الويب، تطوير تطبيقات الويب، النمذجة السلوكية الكائنية الحركة الدائرية و الدورانية .

Development of LECRM (Learning Environment of Circular and Rotational Movement) in Physics by Using Object behavioral Modeling

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Abstract

The research aims to develop an interactive environment for selective topics in physics. This subject is one of the subjects which taken in sixth class of Iraqi secondary schools. Topics focuses on the Circular and Rotational movement. Most challenges which facing students' lies in remembering the convenient laws (rules) and how to minimize the difficulties of applying them step by step.

We develop LECRM (Learning Environment of Circular and Rotational Movement), which consists of authoring tool for teachers and interactive navigation tools for students.

In the design stages of the LECRM development, we use UML language which supports the modern upcoming design principles; such as modularity and reusability. UML used to present the conceptual and behavioral models of LECRM objects and classes. The system has an inference tool used by students to produce / preview the detailed steps of the solution. In the system construction we use Wamp web application server with MySQL for database and PHP language for interfaces designs. The LECRM was tested in one local basrah secondary school by teachers and student

Introduction

The Scientific development progress especially in the electronic field and Informatics had an impact on all walks of life, and the education sector was not an exception, as it affected by the educational process technology ,step by step ;it is leading to the what we called e-learning.

Education in e-learning is characterized by its ability to increase interaction between students, teachers, and the content of scientific material and the interesting transition in the scientific material. It is formulizing the educational process in another form focused its attention on the recipient (the student and even the teacher).

The primary benefit of establishing this learning environment is very clear and understandable, and this area in education still requires a lot of the searching and constructing, as well as guidance on the best use of capabilities provided by these environments [1].

As a solution, we present LECRM (Learning Environment of Circular and Rotational movement in physics), and this environment consists of two interrelated main parts:

1- *An authoring tool* : used by teacher to prepare a number of questions in the circular and rotational movement subject.

2- *An interactive navigation learning environment*: used by student can use to learn about the topics that has been prepared through an interactive interface .

This interface provides two ways to interact with student:

1- Fill out the *values of variables* in the equations, or

2- Write the *text questions* in the subject.

After an overview regarding selected related work, we present the application Software Behavior of LECRM, its system architecture with Conceptual & Navigational Model, Object Behavioral Model, System Functionality. We conclude the paper with a discussion of the lessons learned and an outlook on future research.

Related work

Several studies have been conducted to demonstrate the effectiveness of using computer in learning and education to achievement of cognitive skills and educational goals, we can mention some of it ,such as:

In 1988 Skinner see that's improving students' attitudes toward of using of computers in educational situations is a key factor to justify the cost of use it in learning and teaching in universities and institutes of education [2].

While in 1992 , multi-modal and real-time simulation, have been considered by Osberg as a highly suitable for applications in the field of education [3].

In 1995 , Bawi / University of Baghdad - College of Education: Concluded that the use of computer multimedia in teaching of physics for students of the fifth scientific , could increase the positive use of computers in learning and education with a high degree of control and self-discipline in the classroom compared to the classroom when using other educational technologies ; thus reduce the failure rates that result from the inability of students to follow-up lesson.[4].

Forbus , Gentner, diSessa, and Vosniadou, decided that trying to representing rich knowledge (like physics) that demand's deep conclusion to be understandable by learning without the help of an automatic system, is almost impossible. An automatic system presents a "learning strategy" to the physics subjects. [5,6,7]

in 2006, LEMMA: a "Learning Environment with Multi-Media Augmentations", a system is designed to develop, evaluate and evolve multi modal learning content of various kinds were presented, which it contains an interactive hypermedia presentations, and learning environment in physics course [8].

In 2008 ,Ministry of National Education in the Republic of Algeria Produce an interactive program uses a computer to: providing data and processing of simulation and application of concepts, laws, principles,

methods and theories in article of Physical Sciences for the second year of secondary education , and linking the results to the MS Excell application. [9]

Software Application Behavior

The core of every software application (Web-based or not) is its domain or conceptual model. It must reflect which objects the application deals with, their relationships and behaviors [10]. In LECRM the conceptual model is specified using the UML notation.

The distinctive aspect of Web applications is their navigational architecture: they are basically database applications. We must define which objects (nodes) the user will perceive and how he will traverse the hyperspace (links, indexes, etc). Nodes and Links are defined according to the user profile and the task he must perform[11].

Consider the domain of LECRM, i.e. web-based applications that help manage instructor's and student's information in the process of reviewing , updating and modifying . A possible conceptual & navigational model for this domain is given in Figure (1). Notice that this model allows reviewers to express their information, courses and marks in the study year.

For the purposes of supporting the evaluation process, we have defined a "view" over this schema, where Nodes and Links are observers of conceptual classes as shown in Figure (1).

Each Node class can be defined by combining attributes from different conceptual classes, while links indicate navigation paths and reflect conceptual relationships.

For example, "Student" has incorporated "Stage" & "CourseCode" as an attribute; similarly, "Teacher" has also incorporated "Specialist" & "CourseCode" as an attribute.

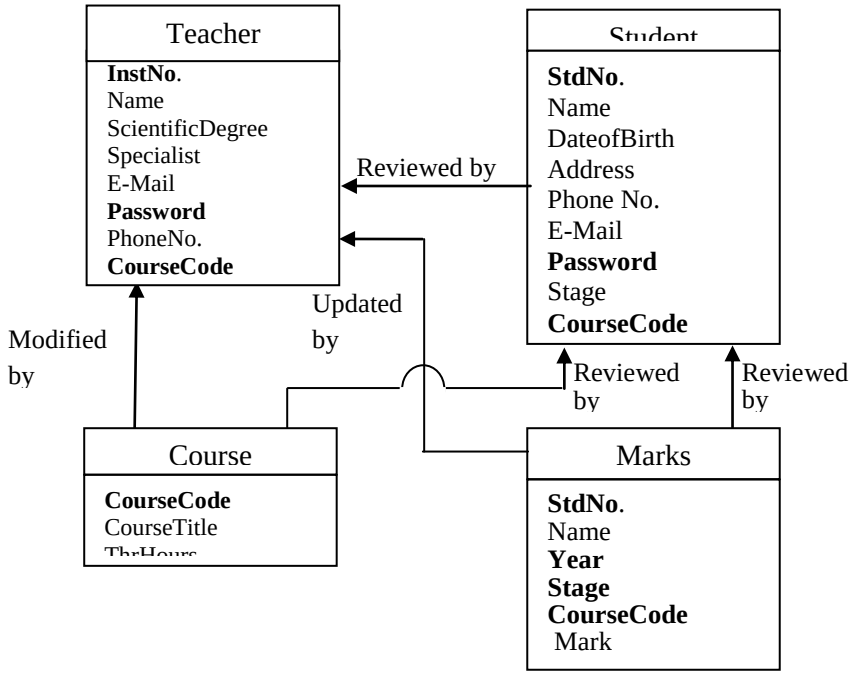

Figure (1)
Conceptual & Navigational Model for the "LECRM "

Object Behavioral Model

Behavioral Modeling is one of fundamentals principles of all requirements analysis methods. A behavioral model shows the interactions between objects to produce some particular system behavior that is specified as (use-cases) which are sequence diagrams (or collaboration diagrams) in the UML used to model the interactions between objects [12].

Use – cases, also, are a scenario based technique in the UML which identify the actors in an interaction and which describe the interaction itself [13]. Scenarios are real-life examples of how a system can be used as shown in figure (2) teacher use-case model and figure (3) student use-case model [14].

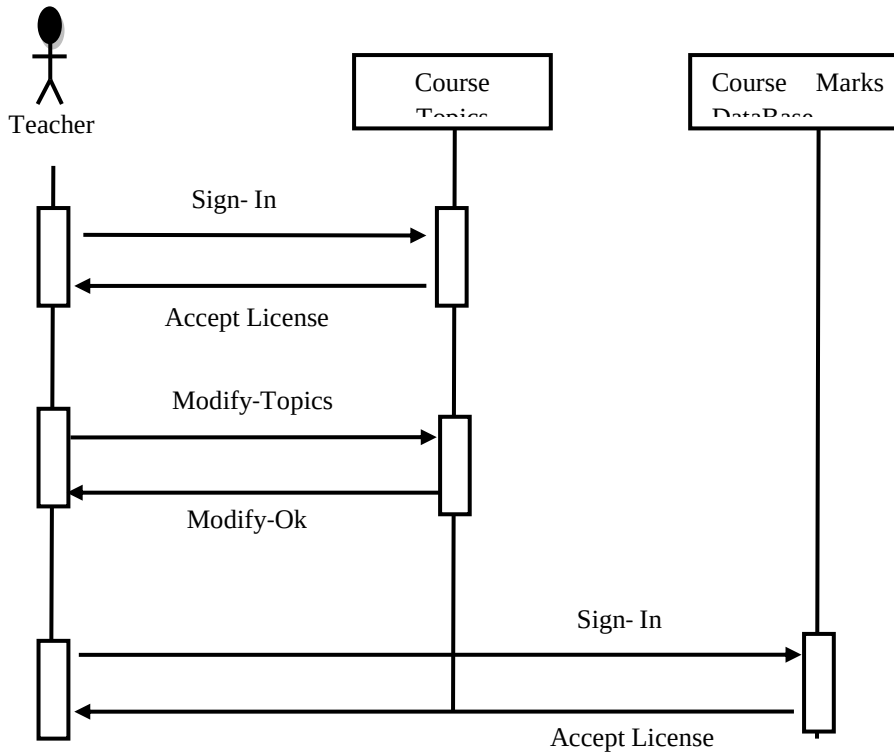

Figure (2) – Teacher use-case model

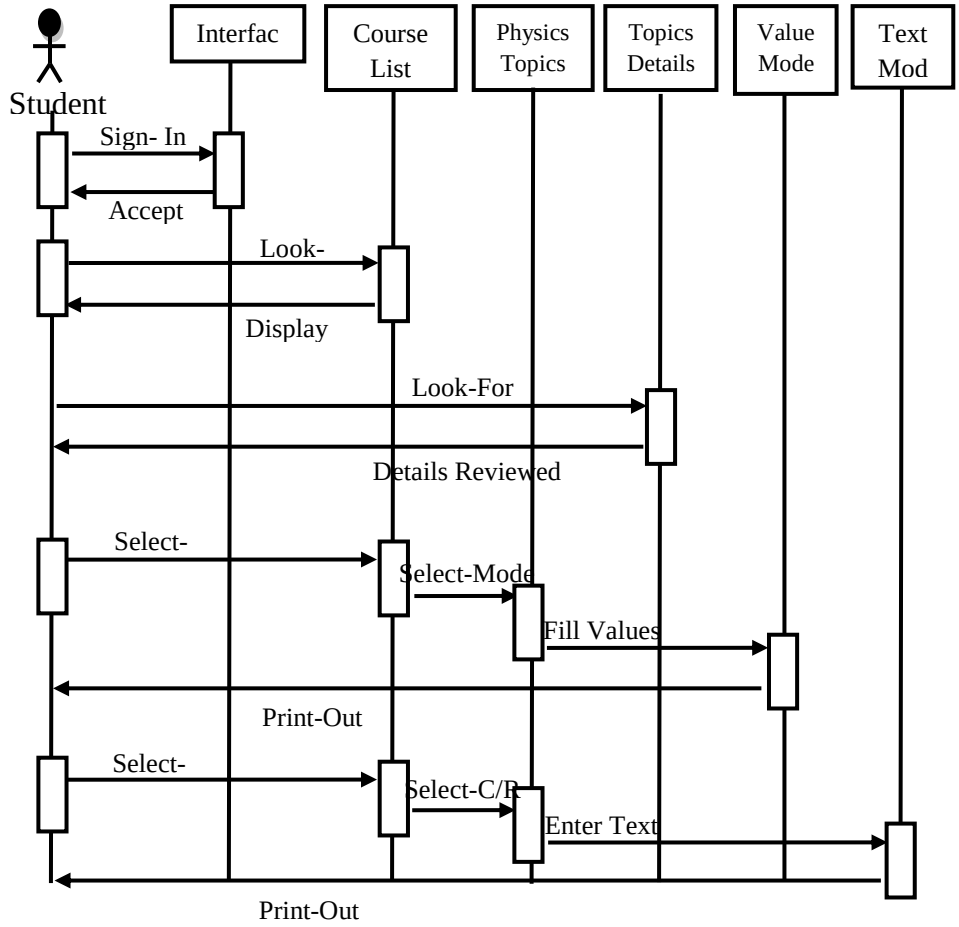

Figure (4) Student Use-case

The Circular and Rotational Movement In physics

This research discuses two basic types of movement:

1- circular movement:

Determined by the presence of a *Central force (F)* which forcing the moving object to starting in a circular path with the *velocity (speed)(V)* and *central accelerate (A).*

Object Speed determines the type of circular movement, if it fixed along the circular path then the circular movement will be regular, Otherwise, the circular movement would be irregular.

Object force moving in circular movement directly proportional with the *mass (M)* of the object and the value of accelerated.

If there is a force move that object in a circular movement will produce a certain time rate of change in speed, which depends on the start of the moving object and the *radius (R)* of the circular path.

Here is some of direct Laws for circular movement and how to infer indirect Laws:

$$F = M \times A$$

$$A = \frac{V^2}{R}$$

$$\therefore \quad A = M \times \frac{V^2}{R} \ldots\ldots\ldots (1) \qquad \text{---------- \{ direct law \}}$$

As an example .. We can infer an indirect law from the law (1) above as follows:

$$M \times V^2 = F \times R$$

---------- { indirect law }

$$\therefore \quad V = (F \times R / M)^{1/2} \ \ldots\ldots\ldots (2)$$

where :

F : Central Force.

M : Mass .

A : Central Accelerate.

V : Velocity (speed) .

R : Radius of the circular path .

The indirect law (derived from the law (1) above) enable to find out the speed starting for object moving in circular path through to know the values of the Central force and the Radius of the circular path and the Moving Object Mass.[9,15]

2- Rotational movement:

Determined by the presence of a solid object mass revolves around the specific center - not around a circular path - with a regular or irregular speed. The rotational movement organizes under three Newton's laws and their situations in terms of angular momentum and angular impulse and inertia, and other laws that govern of rotating objects, and we can from this laws inferred the indirect laws as above in circular movement. [9,15]

System Functionality

The inference engine in this Environment can infers the solution for questions of The circular and rotational movement by using the following Interactive Tools:

1- Tool includes all the basic variables of the circular and rotational movement rules, where you can choose and fill a combination of them by the values which given by the question, then select the desired variables to produce its values later.

2- Tool includes type of the question in the circular and rotational movement, this tool analyzes question vocabulary, and identify variables and its values, then select the desired variables to infer its values later.
3- Tool infers the values of desired variables according to the variables values are given in the question and the circular and rotational movement laws in the data base.
4- Tool shows how to infer the solution and how to access it by set of steps include the laws that were used in finding the solution.

The Inference tools in above show in the following figure (5) Inference Tool Method.

```
Method InferenceTool ( )
  Enter Mode
  If Mode= "TextQuestion" then
     Enter TextQuestion
     Analyzing Text
     Get important Values
  Else                              {Variable Value Mode}
     Enter Variables Values
     Get required Values
  EndIf
  Select Laws                       {From Data Base}
  Calculate Results
  Fill/ Type                        {Values/ Text Question}
  Save Solution Steps in Data Base
  Print Solution Steps as Document
End.                                {End Method InferenceTool }
```

Figure (5)
Inference Tool Method

Evaluation and Conclusions

Through our observations of users interacting with the system and through evaluation of a tutorial with the system, we can already provide a few hints on how to design interactive learning environments and content. Regarding the environment itself it seems to be of value to give the student the option of different modalities but leave it's particular utilization open.

There is no evidence, but the notion, that the interactive setup enabling the student experiment seems to work fine for building conceptual understanding. As a tool for designing educational content, the authoring environment's most important attributes are relief from technical details (encoding, consistency) and supporting feedback.

When writing content for an educational system like LECRM, the author should keep in mind to provide many occasions for experiments between small chunks of knowledge and to give very detailed instructions to the student.

We presented the concept, implementation and first evaluation of an interactive learning environment. In a study with physics of secondary schools students involving actual curriculum material, we found the system to be a valuable supplementary to daily class. Participants learned the content and enjoyed using the system. We think that with using LECRM we will be able to support beneficial learning patterns for computer-aided tutorials.

This research could contribute to help researchers in the field of computer-aided learning, computer science, education, and physics teaching and through trial and evaluation, we found that LECRM can contribute to:

1- Increased interaction between the student and the teacher and scientific topics in this subject.

2- Make the students able to understand scientific topics and to find better solutions for given questions.

Additional high-potential studies include collaboration in teacher-to-student or student-to-student scenarios. Furthermore tutorials are intended for other areas such as chemistry, languages, or sports.

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