ARDUINO Tutor: An Intelligent Tutoring System for Training on ARDUINO

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***Abstract:** This paper aims at helping trainees to overcome the difficulties they face when dealing with Arduino platform by describing the design of a desktop based intelligent tutoring system. The main idea of this system is a systematic introduction into the concept of Arduino platform. The system shows the circuit boards of Arduino that can be purchased at low cost or assembled from freely-available plans; and an open-source development environment and library for writing code to control the board topic of Arduino platform.*
The system is adaptive with the trainee's individual progress. The system functions as a special tutor who deals with trainees according to their levels and skills. Evaluation of the system has been applied on professional and unprofessional trainees in this field and the results were good.

KEYWORDS: Intelligent Tutoring System (ITS), Arduino Platform, Microcontroller, Open Source, Cognitive Learning Theories, Authoring Tool.

1. INTRODUCTION

An intelligent tutoring system (ITS) is software that aims to provide immediate and specific instruction and feedback to trainees, typically without referring to a human trainer. The goal of ITSs is to facilitate learning in an evocative and efficient way by using different computing techniques. ITSs have proven their abilities in both official education and professional situations. There is a strong association between intelligent tutoring, cognitive learning theories and design. An ITS aims to solve the problem of over-dependency of trainees over trainers for superiority education. It intends to offer access to high-class education to every trainee, consequently improving the whole educational system [1].

One of the advantages of ITS is its ability to deal with different fields. For instance, there are many different microcontroller development platforms available for use in training and prototyping with electronics, used for everything from new musical instruments to intelligent electronics projects, custom input devices and interactive art pieces. These tools attempt to decrease the difficulty of working with electronics and increase the number of people who can experiment with the medium. One of these open source tools is Arduino prototyping platform which makes working with electronic components easy, cheap, and quick [2]. The Arduino is a microcontroller development platform paired with an intuitive programming language that can develop by using the Arduino integrated development environment (IDE) software. By equipping the Arduino with sensors, actuators, lights, speakers, add-on modules (called shields), and other integrated circuits, it can turn the Arduino into a programmable "brain" for just about any control system [3].

This paper presents an intelligent tutoring system for training on Arduino platform.

2. LITERATURE REVIEW

There are many research papers and ITS tools that have been developed in many fields such as medical, educational, and computer science fields. There are various intelligent tutoring systems designed and developed for the education purposes. Some of these ITS are designed for teaching such as [4-6], effectiveness of e-learning [7], A comparative

study between Animated Intelligent Tutoring Systems (AITS) and Video-based Intelligent Tutoring Systems (VITS) [8], ITS developed to assist students in learning logic and helps students to learn how to construct equivalent formulas in first order logic (FOL) [9], Teaching Java objects Programming language [10], ITS for helping English Language students to teach English Language [11], Java Expression Evaluation [12], Linear Programming [13,14], ITS for teaching the right letter pronunciation in reciting the Holy Quran [15], effectiveness of the CPP-Tutor [16], ADO-Tutor: Intelligent Tutoring System for leaning ADO.NET [17], teaching database to sophomore students in Gaza [18], Predicting learners performance using NT and ITS [19], and intelligent tutoring system for teaching advanced topics in information security [20], an agent based ITS for Parameter Passing In Java Programming [21], Design and Development of Diabetes Intelligent Tutoring System [22], ITS for stomach disease Intelligent Tutoring System [23].

3. ARUINO TUTOR ARCHITECTURE

The authoring tool intelligent tutoring system Builder (ITSB) [1] has been used to design and develop ARDUINO tutor. This tool as any normal ITS has four fundamental modules: user interfaces module, Pedagogical module, student module and domains module and figure (1) shows the relations between these modules.
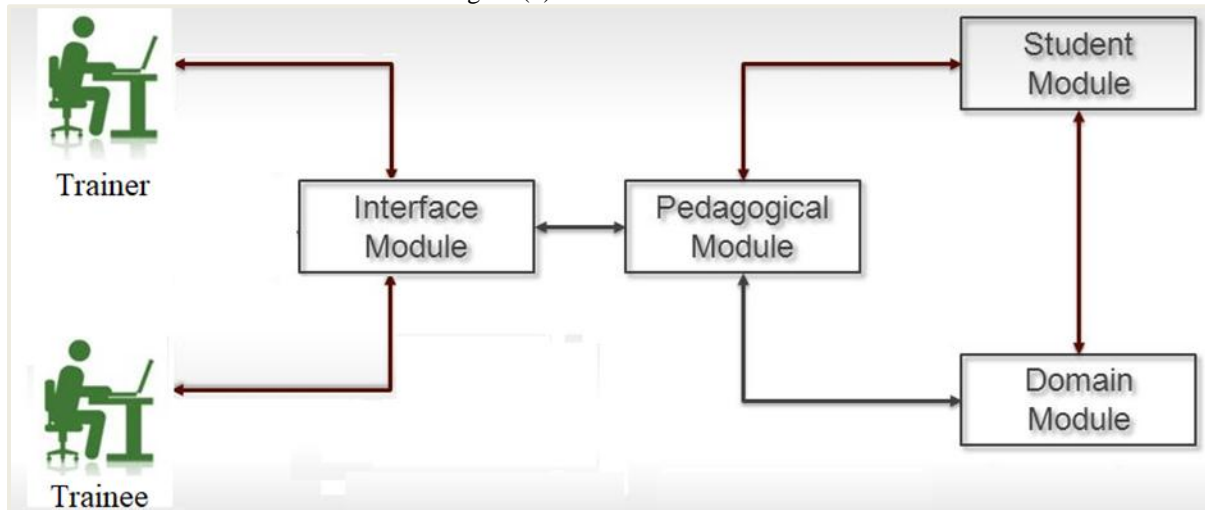

Figure (1): The Architecture of ITS.

3.1 PEDAGOGICAL MODULE

This module works as a coordinator which controls the functionality of the system. Through this module, a trainee can gradually move from a simple level to more advanced ones. He has to answer 75% of the exercise in order to move to the next level, but if he doesn't, the module will refer him to the lesson of this level then he will repeat the examination at the same level.

3.2 DOMAINS MODULE

This module is responsible for the lessons, its arrangement, and a range of elements. The material covered in the ARDUINO TUTOR is as follows:
- Lesson 1: Arduino
- Lesson 2: Arduino Boards
- Lesson 3: Download the Software and driver
- Lesson 4: The Integrated Development Environment (IDE)
- Lesson 5: Write First Program
- Lesson 6: Built First Electronic Circuit

3.3 STUDENT MODULE

In this module, every new trainee has his own account and profile which allow the trainee to study course materials and do the exercises. The profile has information about the student such as date of last visit, student name, student
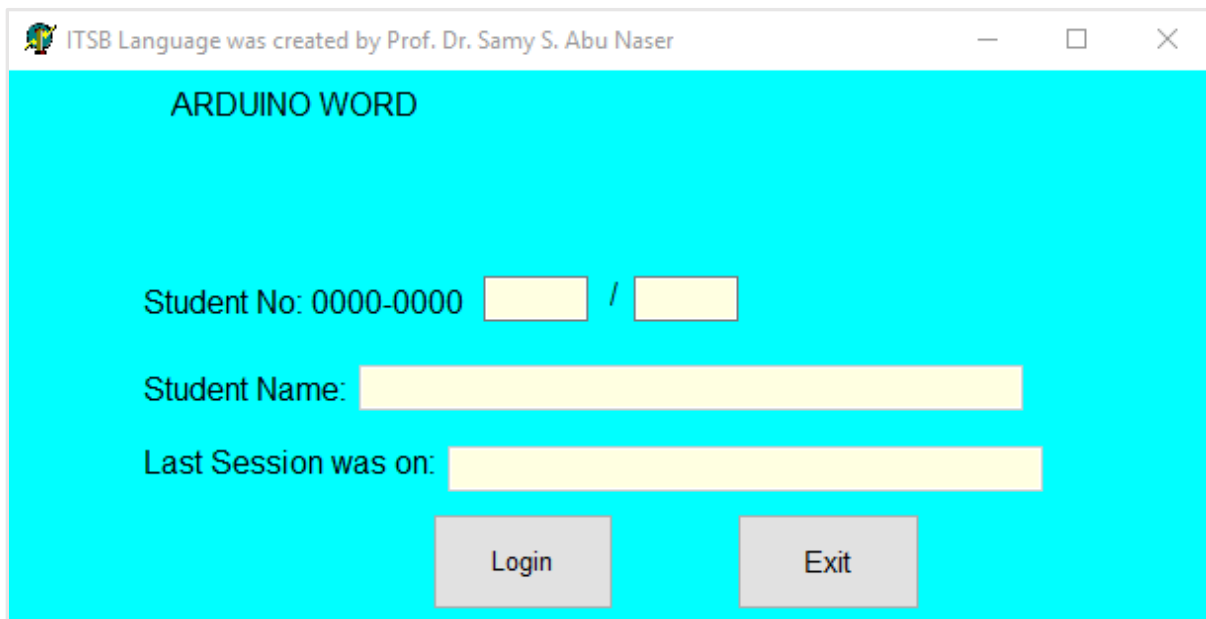
number, current score, and overall score. The current score represents student score for each level. The overall score represents student for all levels.

3.4 USER INTERFACES MODULE

This module is divided into two sections:

1. Trainer interface: the admin only can access to this interface and add lessons, examples, exercises, modification and deletion, adding trainees' accounts, adjusting the color and many other settings of the system.
2. Trainee interface: this section is designed for trainees where each trainee can review the lessons, examples, and solve the exercises.

Figures (2-11) are screenshots of trainer interface and trainee interface.

Figure (2): Student Login Form.

Figure (3): Form for adding ITS Basic Data.

Figure (4): Form for adding Students Data.

Figure (5): Form to adjusting Font type, color & Size of all screens of the ITSB.

Figure (6): Form for adding New Lesson and Example.

Figure (7): Form for adding questions and answers.

Figure (8): Form for Edit Lessons and Examples.

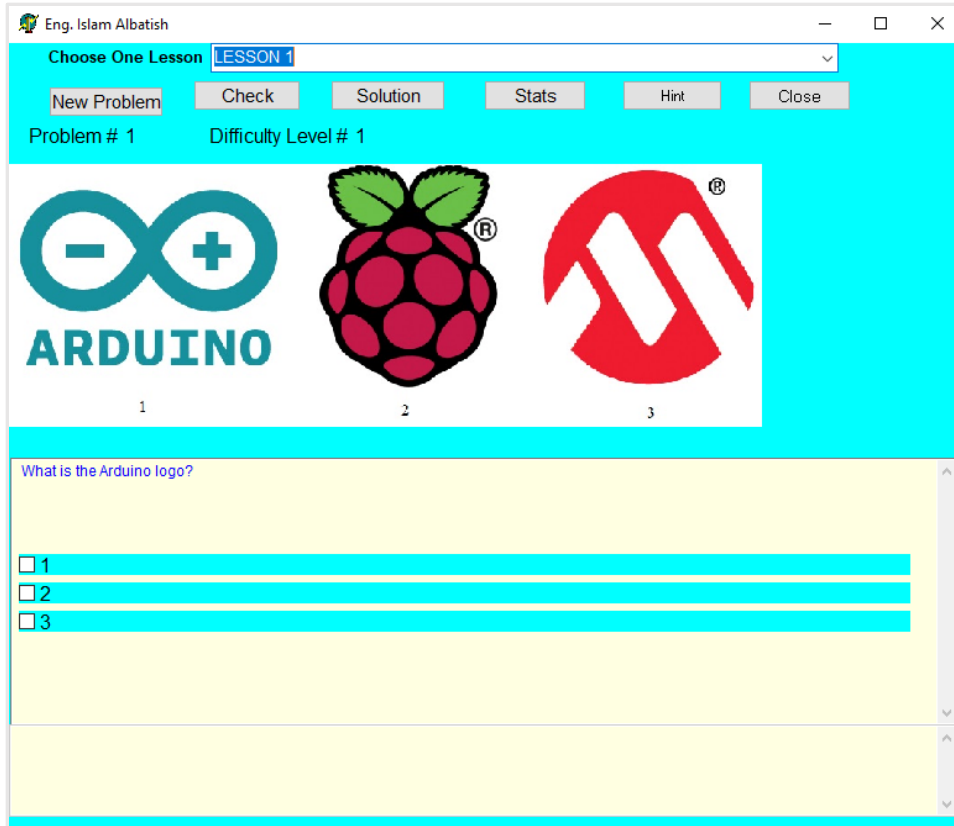Figure (9): Form of Student lessons and examples.
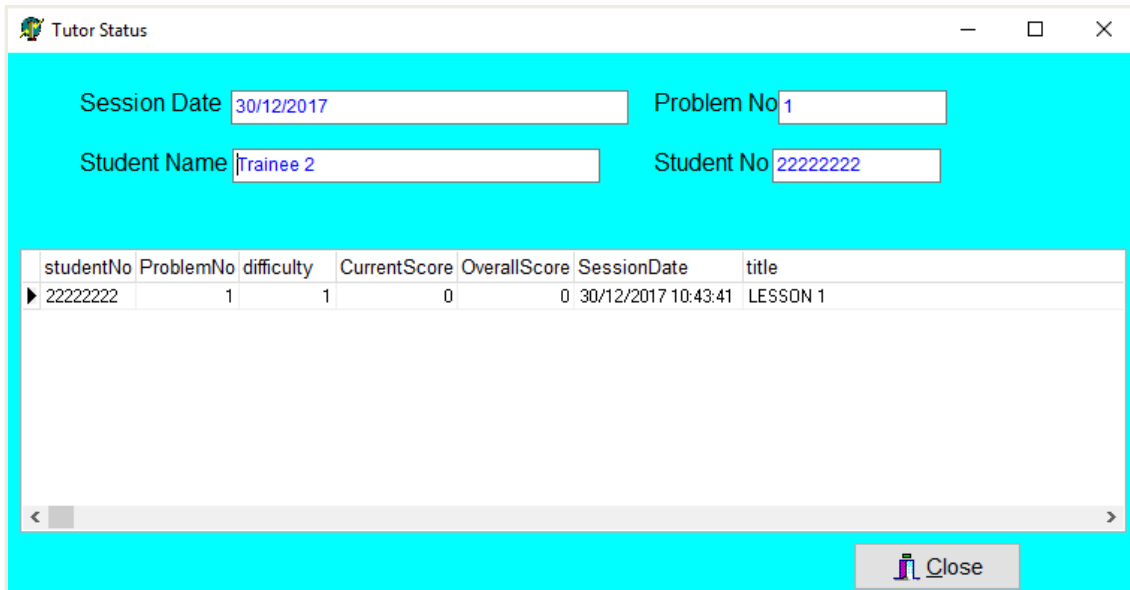
Figure (10): Form of Student Exercises.

Figure (11): Form of Student statistics.

4. ARDUINO TUTOR EVALUATION

An evaluation was carried out on a group of professional and non-professional people in order to assess the quality, efficiency, and effectivity of the Arduino tutor. The result was good as shown in table (1).

Table (1): The results of the evaluation.

S.	Item	Rate %
1	The Quality of the Design?	86
2	The System is efficient?	91
3	Did you find user interface of the system helpful?	88
4	Would you like to see similar tutoring system in other courses?	93

5. CONCLUSION

ITSs are considered as future's tutoring system which can take trainer's place. They save costs, time, and efforts in addition to their adaptability to individual differences between trainees.

In this paper, the researchers have designed an intelligent tutoring system for trainees learning Arduino platform using ITSB authoring tool. The system was designed for trainees who want to learn or develop their skills in this field easily and smoothly. The evaluation approved the affectivity of the tutoring system.

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