Building Learner Model for School Students Based on Multi-Entries from Students, Parents, and Instructors

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I, Ali A. Al-Jadaa, declare that this thesis titled, 'Building Learner Model for School Students Based on Multi-Entries from Students, Parents, and Instructors' and the work presented in it are my own. I confirm that:

- This work was done wholly or mainly while in candidature for a master degree at Birzeit University.

- Where any part of this thesis has previously been submitted for a degree or any other qualification at this University or any other institution, this has been clearly stated.

- Where I have consulted the published work of others, this is always clearly attributed.

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- I have acknowledged all main sources of help.

- Where the thesis is based on work done by myself jointly with others, I have made clear exactly what was done by others and what I have contributed myself.

Signed:


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بسم الله الرحمن الرحيم

"قل لِنَصَلَّي وَنُسُكِي وَمَحْيَايَ وَمَمَاتِي لِلَّهِ رَبَِّ الْعَالَمِينَ، لاَ شَرِيكَ لَهُ وَبِذَلِكَ أُمِرْتُ وَأَنَاْ أَوََّلُ الْمُسْلِمِينَ". (القرآن الكريم - سورة الأنعام)

صدق الله العظيم
Abstract

Building Learner Model for School Students Based on Multi-Entries from Students, Parents, and Instructors

by Ali A. Al-Jadaa

Accuracy of student model is the heart of any Intelligent Tutoring System (ITS), whenever it becomes more accurate, the system becomes more intelligent. In the earlier versions of ITS, the student must submit a test before using the ITS. This test will be used to build the student model, which contains information about the knowledge of the student, his/her misconceptions, preferences and other related issues. However, this method doesn’t work effectively for school students, because one test can’t accurately evaluate their knowledge and misconceptions. In this research, we implement a system to get the student model for school students by allowing the students, parents, and instructors to add their assessment and feedback to the model. Then the system uses these multi-entries together with the traditional test to build an enhanced student model. Furthermore, in order to support collaborative learning, the student will get access to open this model for other instructors and peers. The proposed system has been applied on a group of students, their parents and instructors. The student’s knowledge has been improved. also the parents where pleased to be engaged in the educational process.
بناء نموذج المتعلم لطلبة المدارس بناء على مدخلات متعددة من الطالب وولي الامر والمعلم

دقة نموذج الطالب هي قلب التعلم الإلكتروني الذكي، وكلما كان النموذج أكثر دقة كان النظام أكثر ذكاء. في الإصدارات السابقة للتعلم الإلكتروني الذكي كان على الطالب التقدم لامتحان قبل استخدام النظام فقط. هذا الامتحان يستخدم لبناء نموذج الطالب، الذي يحتوي معلومات عن مستوى معرفة الطالب والمفاهيم الخاطئة لديه أو ميوله أو أمور أخرى. الطرق التقليدية في بناء النموذج لا تكون فعالة لطلبة المدارس لأن الامتحان وحدة لا يكون دقيقا كفاية لتقييم مستوى معرفة الطالب والمفاهيم الخاطئة لديه. في هذا البحث سوف نبني نظاما يجنبنا تحصيل نموذج للطالب بان يسمح للطالب وولي الامر والمعلم بادخال تقييمهم وتغذيتهم الراجعة عن الطالب للنموذج. ثم النظام سيستخدم هذه المدخلات المتعددة مع الامتحان التقليدي لبناء نموذج محسن للطالب اضافة إلى أنه سيدعم التعلم التعاوني للطلبة، وسيعتمد النموذج على النموذج المفتوح الذي يتيح للطالب مشاهدة ونقاش النظام حول النموذج الخاص به. بالإضافة للمعلم وولي الامر، وقد استطعنا رفع معرفة الطلاب كذلك اشركتنا أولياء الأموار في العملية التعليمية.
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...
To my father with love and respect...
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Abbreviations

AI    Artificial Intelligence
CAI   Computer Assisted Instruction
DK    Domain Knowledge
ICT   Information Communication Technology
ITS   Intelligent Tutoring System
OLM   Open Learner Model
SK    Student Knowledge
SM    Student Model
SMILI Student Model Invite Learner In
UI    User Interface
UK    Unrecognized Knowledge
UML   Unified Modeling Language
Chapter 1

Introduction

With the huge development in the Information Technology and the wide spread of the Internet, which becomes an essential source for receiving information, many developers tend to implement educational systems that participate in rising the educational level through Information and Communications Technology (ICT)[1][2]. These systems were able to spread all over the world, and they raised the educational level of students. Nevertheless, they could not replace the real teacher who takes into account the individual differences between students, and he/she provides the suitable information for students that fits in with their educational level. In later time, more accurate and intelligent systems appeared and tried to simulate the human teacher in his/her ability in defining misconceptions with students and providing solutions. These systems are regarded as Intelligent Tutoring Systems ITSs. This thesis concentrates mainly on the students’ model and enhances the ability to diagnose the student more accurately in these systems.

This chapter shows an overview of the Intelligent Tutoring System (ITS) and the thesis motivation. Section 1.1 describes the motivation. Section 1.2 presents the research objectives and problem statement. The summary of progress and contribution of this thesis in section 1.3. At the end, it shows the organization of the thesis in section 1.4.
1.1 Introduction and Motivation

The student’s knowledge level is an essential part of the educational process, and it is a main part of the ITSs. The ITSs classically depend only on a short test to evaluate the students and it is the only entry for the student model\[3\][4]. However, the short tests or exams only do not usually reflect an ideal image of the student’s level. In fact, the exam could be one of the factors that causes an aversion from the student towards learning. It may also be the main factor that makes the student feel frustrated and he might leave school. At the same time, we cannot neglect the exam’s evaluation because it can be easily applied to get a perspective about the students’ level. That is why in this research, we are going to supply the ITSs with other entries features to evaluate the student to reach a better student model accuracy, in addition to make students more pleased and self-confident, and that encourages them to learn effectively.

This research will specifically be for school students, and the final system will be an integrative system with the school without cancelling its role. We will depend on four sources to enter the evaluation in the student model: Firstly, the student evaluates himself/herself based on the subject that he/she is going to learn. This is important because we really want to know from the student himself his/herself her educational needs to achieve them better. Secondly, the teacher evaluates the student. The closest person to the student educationally is his teacher in school. If we take benefit from this accumulative experience of the teacher about the students’ level and their educational needs, that shall give the system a bigger ability to evaluate the students more accurately. Thirdly, the parents evaluate their children. It is known that most parents care about their children’s level, and they are interested in raising their children’s educational level. Therefore, they are often aware of their children’s needs or at least part of them. As a result, the system will use this evaluation and benefit from it. In this way, parents actually participate in developing the educational process for their children. Finally, the system evaluates the student. This is a former procedure used in ITSs. It is basically a short test to the students’ level. Then, after collecting the four opinions
concerning the students’ level, the central system studies all these opinions, and it
gives us detailed and accurate results about the educational needs for the students
and their educational performance.

1.2 Research Objectives and Problem Statement

Our Proposed model is to build the students’ model for students in the middle
and higher grades (e.g. from 8th grade to 12th grade). The students at this level
depend on their teachers and parents to help them get their knowledge. Moreover,
the students at this level can assess themselves, determine their interests, and have
good knowledge about computer/mobile software.

The main objectives of this research are:

1. Implementing an enhanced student model by allowing the students, parents,
and instructors to add feedbacks to the system.

2. Investigating how we can support the students to negotiate with the system
regarding the contents of their models?

3. Investigating how we can support students with ITS which use open learner
model? .

4. Evaluating the effects of building such a model on students’ performance,
especially on collaborative learning between peers.

1.3 Summary of Progress and Contribution

Our contribution is to involve the assessment of students, teachers, and parents in
building the student model. By this, the system will have more resources about the
students’ knowledge level, which shall make the final assessment of the students
more accurate. However, the data entered by these different actors may have
some contradictions regarding the students’ knowledge. In this case, the system will use some defined rules to build an optimized learner model. The student can still negotiate this model if he/she thinks that it does not reflect his/her real knowledge as shown in figure 1.1.

Choosing the weight for each type of assessment for students takes a long time and considerable effort. In our research, we was determine the weights through interviews with educators who have much experience in this area.

The weights for each assessment type were put as the following:

1. The biggest assessment weight is given to the system assessment (35%). The system evaluates the student in five different concepts with multiple questions for each concept. The registered values for the students are from 50.

2. The second assessment weight is for the instructor (30%) because he is the closest person to the student in the real education world based on interviews of educators. Therefore, the instructor is the best who can give us a clear
picture about the students’ knowledge level. The system allows the instructor to assess the student in five concepts, and the concept values are from 50.

3. Student self-assessment, which is based on the questionnaire that we prepared to find whether the students can assess themselves and can determine their educational needs. So the weight of the student self-assessment is (20%). The system allows the student to assess himself/herself in five concepts; the value for each concept is from 50.

4. Parent assessment, which has the lowest weight. Based on interviews of educators, the parents are not actually in contact with their children, but there are a few number of parents who want to contribute in their children’s education. As a result, we hold a meeting to describe the importance of their contribution for their children. The parent assessment is (15%). The system allows the parents to assess their children in five concepts, for each concept, the value is 50.

In addition, we will work to support learning reflection by making the model open for the students themselves, teachers and parents. In other words, the students shall get into the habit of linking and constructing meaning from their experiences or by viewing their model[5]. the student learning and We will also support collaborative learning by giving the students the access to open the models for other peers. This will help the educational process in several aspects, [6] ”Successful collaboration means asking questions to gain a better understanding of the main concepts, elaborating and justifying opinions and sharing and explaining ideas”, and they will be achieved with open model, especially between peers[7]. Another contribution for this work is to make the student model negotiable and that means the student can negotiate (limited with some rules) with the system, about his/her model.
1.4 Feasibility Study

Some questionnaires were prepared for students, teachers and parents (see appendix A). These questionnaires had four objectives. Firstly, to know the confidence of the students, teachers and parents on the exam to determine the knowledge level and the educational needs for students. Secondly, to know the students’ confidence about themselves and their ability to determine their educational needs. In this way, the teacher will use this self-evaluation to choose the best pedagogical strategies. Thirdly, to know the ability of teachers to determine the level of their students and understand their educational needs in order to improve the educational process in general. Finally, to know the ability of parents to follow up their children and determine their needs, and to share this knowledge with the teachers so that they can develop the educational process as well.

The results of the primary analysis for the questionnaire were as the following:

1. There was a lot of confidence that the exam is irreplaceable because it’s good and can easily be applied; the rate was 69%. The standard deviation of the data was less than 0.9, and that is an indicator of agreement.

2. There was a lot of self-confidence between students that they are capable of identifying their needs and pass them to their teachers; the rate was more than 90%. The standard deviation of the data was less than 0.7, and that is an indicator of a big agreement.

3. The students were confident with their teachers to determine their weaknesses and fix them, and to choose the suitable educational strategies for each one; the rate was 70%. The standard deviation of the data was less than 0.9, and that is an indicator of agreement.

4. The students were confident with their parents that they had the ability to determine their educational needs and transfer this assessment to the teachers; the rate was 63%. The standard deviation of the data was less than 1.0, and that is an indicator of agreement.
In conclusion, students really prefer to have other entries which locate their educational needs in order to raise their knowledge level. Moreover, these entries give them better options and better pedagogical strategies.

*Note: All the data analysis of the questionnaires was attached in addition to the percentages, the standard deviation and the statistical diagrams which reflect all these analysis in appendix B.

1.5 Organization of the Thesis

In addition to this brief introduction, this thesis report includes Chapter 2: Background and Literature Review, which includes an overview about E-learning Environments, Intelligent Tutoring System, Intelligent Tutoring System Architecture, Student Model and Open Learner Model. Chapter 3: System Requirements, which includes the functional requirements, nonfunctional requirements for the proposed system. Chapter 4: System Implementation and Testing. Chapter 5 about system evaluation. Finally, chapter 6 presents a conclusion and the future work.
Chapter 2

Background and Literature Review

This chapter shows a background about ITS and some old approaches, then presents the four modules of the ITS in detail.

2.1 E-learning Environments

Systems which depend on a technological environment in education are called computer-assisted instruction (CAI)[8]. It also means information and communication technology in education (ICT)[9]. All these terms refer to one concept which is using technology in education. However, the problem of these systems is in the way they function. They present the courses information serially from A to Z without taking into consideration the knowledge level of the student. As a result, these systems don’t distinguish between students, and they use the same technique which is presenting all information only with all students.

Although this system is good to some extent, in fact it doesn’t satisfy the educational needs for specific levels of students. For instance, if a student is weak or has some misconceptions, the system won’t be able to spot these weaknesses, and so they won’t be fixed. Similarly, if the student is excellent, the system won’t be
able to distinguish him, and hence give him more difficult material or speed his learning process. It’s known that the superior student just needs a few hours to understand the course without the need to take the whole course.

This leads us to the necessity of having an educational system which simulates the teacher who measures the level of his students and decides what is suitable for each one of them individually. This system appeared recently, and it was called ICAI\[10, 11\], then it finally improved to become ITS \[3, 12\].

### 2.2 Intelligent Tutoring System Overview

The scientists split into two schools by the early 1980s. The first school and the smaller one was called “Exploration Environments” \[13\], the famous example in this school is LOGO language by Papert \[14\], which introduced the student to learn by programming directly, and he thought the classic school did not have a place in our future life; therefore, some researchers called this school ”Revolutionaries”. However, this school, didn’t achieve success and widespread, because it actually wanted to change radically, and that was impossible without the inserts. The second and the larger school was called “Intelligent Tutoring”, who presented themselves as “Reformists”, and they preferred a gradual improvement, by using AI techniques. Our research will focus on this school.

The term Intelligent Tutoring System (ITS) expresses the development of computer programs for teaching students effectively, in order to provide tutors to know what they teach, who they teach and how to teach it\[13\]. Wenger defined ITS as “Computer-based instructional systems with models of instructional content that specify what to teach, and teaching strategies that specify how to teach” \[3\]. The motivation to build the (ITS) is to simulate the human teacher and effectiveness of one-to-one learning\[3\]. In real classroom, there is one teacher for many students, so it’s difficult to apply the one-to-one approach. Most teachers are trying to take into account the individual differences between students, as-much-as possible, although, some students may be neglected.
Since the advent of computer science, there were many attempts to completely replacing the human teacher with applications. Theoretically, these attempts won’t be science fiction, given in Artificial Intelligence (AI) field. Ideally, advancing in natural language processing allow the system to talk with the student as a human teacher. Developing a powerful ITS must have a combination of computer science (AI), cognitive psychology and educational research as shown in figure 2.1), so many researches in this field are producing by involving scientists in computer and education.

Practically, this ambition is facing many challenges. Firstly, natural language processing is not yet good enough to emulate a real conversation between a student and a teacher. Secondly, (ITS) can’t completely replace a human teacher because there is some students who are not suitable with application-based instruction, in addition, some topics are not appropriate for application-based instruction.

![Figure 2.1: Intelligent Tutoring System.](image)

### 2.3 Intelligent Tutoring System Architecture

In the literature, there is no clear general structure of ITS [15], but there are many researches, which are considered as a consensus, say that there are at least three modules, the Expert Knowledge Module, the Student Model Module and
the Tutoring Module [16]. The next researches as Winger’s [3], add User Interface Module to the previous three modules. As a result there are four basic modules in ITS, as shown in figure 2.2.

![ITS Architecture](image)

**Figure 2.2:** ITS Architecture.

### 2.3.1 Expert Knowledge Module

This model means what we need to deliver to the student. That is why many researches called it the heart of ITS [17]. This module acts as a data repository which contains information about the courses, courses content, and the relations between course elements (hierarchy). It is similar to the book index (chapters, sections, subsections . . . ). Principally, there are two types of content or functions in this module, the first one is called Domain Model which is the source of knowledge. In addition, it contains the questions and the problems of the students. The second one is called Expert Model, and this model must generate the solutions, and these solutions will be compared with the student solutions [3].

### 2.3.2 Tutoring Module

This module is the brain of ITS because it will decide the suitable type of content base on the Domain Model for the suitable student depending on the information
about the student that we get from the Student Model. Moreover, it must decide the correct strategy of teaching for each student individually. In addition, this module can decide the next problem selection or next course selection for the student [18]. This module represents a human expert teacher, who can generate knowledge, answer the questions, evaluate student answers and choose the correct strategy for each one.

2.3.3 Student Model Module

It contains information about student’s knowledge, his level, misconceptions and other issues. The student model represents a dynamic model [3], so it contains some functions and roles, which we will describe in section 2.4 in details.

2.3.4 User Interface (UI) Module

The importance of this module comes from [3]. The UI module is the final form in which the system presents a course. In other words, the UI module can make the presentation of the course more or less understandable. This is similar to a teacher in real classrooms, who must convince his students about himself by making a better communication with them, and this process can be crucial to the students’ acceptance of their teacher as well as the system in ITS.

2.4 Student Model

Education is a process of communication between the teacher and the student, and in order to communicate effectively, the teacher must have a clear vision of the student’s knowledge level and the appropriate pedagogical methods for each student individually. That is exactly what the student model presents in ITS, therefore, Holt defined the student model as “representation of the computer
system’s beliefs about the learner”, and “abstract representation of the learner...” [19].

The ITS student model represents competencies and learning achievements [18] for each student, this model may involve three areas [14]:

1. Content skills (e.g., biology, mathematics, history, geography...)
2. Particular strategies for learning (e.g. learning style)
3. Effective characteristics (e.g. emotional state).

Most ITSs identify the level of the student knowledge (content skills), using a short quiz [13], but the particular strategies (learning style) and emotional state are not easy to determine, and they need to be inferred from the student behaviors and observations in long term. In other words, student model represents what the system believes about the student (e.g., misconceptions, plans, goals, knowledge level...), in addition to the student stereotypes, records, and other interactions with the system.

Student model will provide the student’s information to other ITS modules, especially the teaching module, to determine the suitable strategy for each student. On the other hand, the student model may use the domain expert module to identify the misconceptions in the domain of knowledge. Representing the information in student model takes many forms, from simple numeric presentation to complex graphical network [20].

2.4.1 Student model Functions

According to [21], there are three functions in student model. The first one is Evaluation Function, which will evaluate the solutions of the student using the domain model. The second one is Update Function, which will update the information in the student model when it appears. The last one is Diagnosis Function, and this function is used to find misunderstood concepts.
2.4.2 Student Model Types

There are four types of student model according to knowledge types:

2.4.2.1 Overly Model

This type presents the knowledge of the student as a subset of domain knowledge [21]. In other words, this model represents what the correct information that the student knows from the domain knowledge as shown in figure 2.3. (e.g. SCHOLAR, developed by Carbonell 1970)

![Overly Model diagram](image)

**Figure 2.3**: Overly Model.

2.4.2.2 Extended Overlay Model

In this type the student model represents the correct and incorrect (bugs) knowledge, and the system can predict the incorrect information which a student may have [21] as shown in figure 2.4. (e.g. BUGGY, developed by Nagel and Swingen, 1998)

2.4.2.3 Simple Perturbation

In this type, the system considers everything out of the domain knowledge as misconceptions. The problem of this type is that the student’s information may be correct but it does not exist in the domain knowledge [21], and the system will consider it as misconceptions as shown in figure 2.5.
2.4.2.4 Advanced Perturbation

This type is a flexible one because the system assumes that the student may have correct information which does not exist in domain knowledge. So that the system must decide if this information is correct or not[21], as shown in figure 2.6

---

**Figure 2.4:** Overly Model.[21]

**Figure 2.5:** Simple Perturbation.[21]

**Figure 2.6:** Advanced Perturbation.[21]
2.5 Open Learner Model

Most of traditional ITSs depend on close student model, and that means, the student model can be viewed or changed only by the system. Next research as [22] presents the Open Learner Model. The term Open Student Model refers to the term Open Learner Model. Susan Bull defined it as “Learner models that can be viewed or accessed in some way by the learner, or by other users (e.g. teachers, peers, parents)” [23].

2.5.1 Use of Open Learner Model

In the literature, the open learner model is applied in different student modeling techniques such as Conceptual Graphs [24], Bayesian models [25], Fuzzy models [26], Constraint-based models [27, 28], and Simple Weighted Numerical models [29].

2.5.2 Present information in Open learner Model

There are many ways used to represent the open learner model in the literature, for example, Skill meters [27], structured view in OLMlets [30], Arrows in a target [31], level of performances [32], smiley faces [33], trees [34], and the flexi-OLM concept map [35].

2.5.3 Open Learner Model Benefits

Susan Bull in SMILI [36] identifies nine points which may be useful, and we can classify them as:

To Student Himself/Herself

It is very important to the student to view his/her model to know his/her knowledge level to decide the suitable plans to achieve his/her goals. In addition, the student feels that his/her model as a lecture to improve his/her level and exceed
his misconceptions[22]. On the other hand, the student model will be more accurate when the student modifies the information about himself/herself if the system allows update or negotiates the model with the student.

**To Peers**
There are many benefits when the student views the other students’ models or other students view his/her model. About the student, he/she will compare his/her level with other students, and that encourages the competition and enhances collaboration between them [22].

**To Teachers**
The open learner model helps the teachers to decide the level of his/her students and that makes it easy to compare between them. As a result, the teacher can improve the collaboration between his/her students [22]. On the other hand, Susan Bull in [23] said, “the open learner model help the teacher providing formative assessment opportunities for students, but also enabling the learner model to be used as a summative assessment”.

**To Parents**
The open learner model facilitates interaction and communication between parents and their children or parents with their children’s teacher, and that keeps the parents – up to date about the progress of their children.

**To The System**
Susan Bull in [23] determines two benefits of open learner model to the system. The first one is “Increasing the accuracy of the learner model data if the user is allowed to contribute additional or corrective information to enable a more precise adaptive interaction to follow”. The second one is “Increasing learner trust in an adaptive educational environment by showing the system’s inferences about their knowledge”.
Chapter 3

System Requirements and Specifications

In this chapter, we will introduce the proposed system functional and nonfunctional requirements. Furthermore, we will explain the language we will use in the project and other tools.

Four groups of users will use our system:

1. Instructors: This group contains the users who represent the teachers in real world.

2. Students: This group contains the students who take the lectures.

3. Parents: This group contains the parents of each student who register in the system.

3.1 Users (Group Specification)

There are three groups of registered users, who interact with the system. Figure 3.1 shows these users’ hierarchy, and tables 3.1, 3.2, 3.3
Chapter 3. System Requirements and Specifications

Figure 3.1: UML - Users Hierarchy

<table>
<thead>
<tr>
<th>Group Name</th>
<th>Student</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td>The person who learns course.</td>
</tr>
<tr>
<td>Profile Data</td>
<td>Full name, email, address, phone number, picture, the educational level</td>
</tr>
<tr>
<td>Super-group</td>
<td>User</td>
</tr>
<tr>
<td>Subgroup</td>
<td>None</td>
</tr>
<tr>
<td>Relevant use case</td>
<td>Add assessment for himself/herself, edit profile, view his model and view for other peers.</td>
</tr>
<tr>
<td>Object – read mode</td>
<td>His/Her information, his/her model information</td>
</tr>
<tr>
<td>Objects – content management mode</td>
<td>His/Her information, his/her self-assessment, help his/her peers.</td>
</tr>
</tbody>
</table>

Table 3.1: Student’s Description
<table>
<thead>
<tr>
<th>Group Name</th>
<th>Parent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td>The person who is responsible for the student at home.</td>
</tr>
<tr>
<td>Profile Data</td>
<td>Full name, email, address, phone number, picture, the educational level</td>
</tr>
<tr>
<td>Super-group</td>
<td>User</td>
</tr>
<tr>
<td>Subgroup</td>
<td>None</td>
</tr>
<tr>
<td>Relevant use case</td>
<td>Add assessment for his/her child, edit profile, view students’ model</td>
</tr>
<tr>
<td>Object – read mode</td>
<td>His/her information, his/her students’ model information</td>
</tr>
<tr>
<td>Objects – content management mode</td>
<td>His/her information and assessments.</td>
</tr>
</tbody>
</table>

Table 3.2: Parent Description

<table>
<thead>
<tr>
<th>Group Name</th>
<th>Instructor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td>The person who adds the educational material.</td>
</tr>
<tr>
<td>Profile Data</td>
<td>Full name, email, address, phone number, picture, the educational level</td>
</tr>
<tr>
<td>Super-group</td>
<td>User</td>
</tr>
<tr>
<td>Subgroup</td>
<td>None</td>
</tr>
<tr>
<td>Relevant use case</td>
<td>Add assessment for students, edit profile, view students’ model, manage content of knowledge</td>
</tr>
<tr>
<td>Object – read mode</td>
<td>His information, student model information</td>
</tr>
<tr>
<td>Objects – content management mode</td>
<td>His/her information, his/her assessment.</td>
</tr>
</tbody>
</table>

Table 3.3: Instructor Description
3.2 The Functional Requirements

In this section, we will describe the functional requirements for each group of users. To do that, we will use the UML use-case diagram by using Dia Tool v 0.9.

3.2.1 The Instructors’ Environment

The Instructors’ requirements can be captured graphically by using the use-case diagram, and textually by using the scenario description, which will be illustrated in the following sub-sections. Figure 3.2 shows the UML use-case diagram for instructors’ environments, and the instructors’ scenario description as shown in table 3.4.

![Figure 3.2: UML- Use Case :The Instructor Group]
Chapter 3. System Requirements and Specifications

### Instructor Scenario Description

<table>
<thead>
<tr>
<th>Actors</th>
<th>Instructor</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description</strong></td>
<td>The instructor can generate the domain of the course, such as the content of the course, problems and solutions. On the other hand, the instructor in our approach can add assessments for his/her students.</td>
</tr>
<tr>
<td><strong>Precondition</strong></td>
<td>The instructor must be added to the course by the supervisor.</td>
</tr>
<tr>
<td><strong>Sequence Flow of Events</strong></td>
<td>The instructor selects a course and manages the content, problems and solutions.</td>
</tr>
<tr>
<td><strong>Data</strong></td>
<td>Text and numerical information about course domains and the assessments for students.</td>
</tr>
</tbody>
</table>

**Table 3.4: Instructor Scenario Description**

#### 3.2.2 The Parents’ Environment

The Parents requirements can be captured graphically by using the use-case diagram, and textually by using the scenario description, which will be illustrated in the following sub-sections. Figure 3.3 shows the UML use-case diagram for parents’ environments, and the parents’ scenario description as shown in table 3.5.

![UML- Use Case :The Parents Group](image)
Chapter 3. System Requirements and Specifications

<table>
<thead>
<tr>
<th>Actors</th>
<th>Parent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td>In our approach, the parents have a group, which is added by the supervisor to enable them to assess their children.</td>
</tr>
<tr>
<td>Precondition</td>
<td>The parents must be added by the supervisor.</td>
</tr>
<tr>
<td>Sequence Flow of Events</td>
<td>The parents select the model of their children and browse it. The parents are enabled to add, edit and delete assessments for their children.</td>
</tr>
<tr>
<td>Data</td>
<td>Text and numerical information about the course domains and the assessments for students.</td>
</tr>
</tbody>
</table>

Table 3.5: Parent Scenario Description

3.2.3 The Students’ Environment

The Students’ requirements can be captured graphically by using the use-case diagram, and textually by using the scenario description, which will be illustrated in the following sub-sections. Figure 3.4 shows the UML use-case diagram for students’ environments, and the students’ scenario description in table 3.6.

Figure 3.4: UML Use Case: The Students Group
Chapter 3. System Requirements and Specifications

### 3.3 Nonfunctional Requirements

In addition to the functional requirements, which are necessary and essential for the users of the systems, there are some requirements related to the environment itself. The most important nonfunctional requirements are

- **Security:**
  1. Security issues related to the users’ accounts: this requirement mainly focuses on the process of signing out from the system by the user, and then other users should not be able to open that user’s account.
  2. Security against database hackers: All the information about the system’s users is stored in a database server. This database must be protected against any hacker who tries to hack the system.

- **Availability:**
  1. The system shall be available to users all the time, with exception of being down for maintenance no more than one hour per week.
  2. If the system crashes, there should be a backup version each hour.

- **Portability:**

### Table 3.6: Student Scenario Description

<table>
<thead>
<tr>
<th>Actors</th>
<th>Student</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td>A student must get a test in the course, and he/she can see his/her model and open it for the chosen peers. In our approach, the student can add assessments about himself/herself.</td>
</tr>
<tr>
<td>Precondition</td>
<td>The student must be registered in the course by the supervisor</td>
</tr>
</tbody>
</table>
| Sequence Flow of Events | 1. The student gets a test.  
2. The student browses his/her model.  
3. The student can manage his/her model: Edit his/her basic information. Set the state of his/her model (Open, Close). Choose the peers who are allowed to see his/her model. He/She can enter the assessments about himself/herself.  
4. The student can browse his group |
| Data | Text and numerical about students’ information or self-assessment |
1. The system should be able to browse on environments (Desktop, Mobile, and Tablet).

2. The system should be able to support browsers (Chrome, Firefox, Opera and Internet Explorer).

### 3.4 Course Selection

We chose the course of information technology for the 10th grade. The students find it difficult to study this material because it shifts them from using technology to developing it. We also want to present it in a simple way by dividing the material into three levels: high, middle and low, to suit all students’ levels. In addition, we offer some pedagogical strategies such as Brainstorming, Role-playing, Dialogue and Debate and others, which will suit all the trends and tendencies among students.

### 3.5 Programming Languages Selection

We chose the ASP.net programming language, which is simple and easy to use, especially by Visual Studio environment, which provides many tools and frameworks to help developers. This language is accredited by the Ministry of Education in Palestine, which we would like to have partnerships with them. Furthermore, this language is compatible with SQL Server popular database, in addition to the qualities of strength, resilience and the high level of security.
Chapter 4

System Implementation and Testing

This chapter discusses the implementation of the system. Section 4.1 presents the design and implementing of the system database. Section 4.2 shows the implementation of the web application, which includes the student’s environment, parents’ environment, instructor’s environment and the environment of the system’s administrator. Section 4.3 talks about the testing of this web application.

4.1 Design and Implementation of the System Database

We must determine what we need to store in our database. This can be achieved by looking at the system’s requirements:

1. The users of the system: There are many types of users in our system, and each type has basic information as the user ID, name, address, email etc., because of this, we must have a table for users with different privileges.
2. The knowledge content: It is important for our system to store the content of knowledge as concepts, misconceptions, questions, answers and so on. Therefore, we must have a table or set of tables to store these contents.

3. Student Model: The student model is the container of the student’s level about concepts. Therefore, it is important to build a table to store the information about the student’s knowledge, which comes from different entries (system assessment, self-assessment, parent assessment, instructor assessment).

### 4.2 Implementation of the Student’s Model

#### 4.2.1 Students’ Environment

The student has many requirements in the system. Figure 4.1 shows the structure of these requirements. In the next subsections we presents the main pages in students’ environments.
4.2.1.1 Student Profile

The student profile is a page which presents the basic information about the student such as the name, email, parents, level of education etc. The system also allows the student to edit his/her information, as shown in figure 4.2.
4.2.1.2 Student Take System Assessment

The system asks the student to take a test in some selected concepts as shown in figure 4.3. After the student takes it, the system registers that in his/her table. The results will also be registered in the student knowledge table in the database. If the student has the same misconceptions three times, the system will put these misconceptions on record.
4.2.1.3 Self Assessment

This system allows the student to determine his/her educational needs through assessing himself/herself in different concepts. This assessment results will be registered in the student’s assessment table in the database. These results will be presented in the student model later on. The system allows the student to enter the values by using slider or text field as shown in figure 4.4.

![Slider Assessment](image)

**Figure 4.4:** Slider Assessment.

4.2.1.4 Students’ Model

Each student has a model, which presents the results of the four different assessments and these results determine the knowledge level of the student. This system mainly focuses on the open learner model in which the system allows the student to see his model and negotiate about his/her level, see figure 4.5. The student model presents the results in different ways; in graphical bar chart as shown in
figure 4.6, graphical circle pointer as shown in figure 4.7 and data table as shown in figure 4.8. In the other hand, the student can view a list of his/her misconceptions if it is founded as shown in figure 4.9, and the student can view the peers’ models who are in his group. Moreover, the student can help his/her peers in specific concepts. The system calculates the final result about the student’s level of knowledge, which comes from the four entries.

Figure 4.5: Negotiate the System.

Figure 4.6: Chart Bar Result.
Chapter 4. *System Implementation and Testing*  

**Figure 4.7:** Circle Pointer.

**Figure 4.8:** Table of Data.

**Figure 4.9:** Misconceptions list.
4.2.1.5 Students’ Status

This page contains a table about the status for the four different assessments. This table aims to present which assessment type is taken or not as shown in figure 4.10.

4.2.1.6 Students’ Groups

The system allows the student to create a group and other students can add themselves to it. Each group has an admin who is the group creator by default. The student can also search for other groups. The main aim is to create students’ groups to determine the students’ peers, who can view their models or help each other. See figure 4.11.
4.2.2 Instructors’ Environment

The instructor has many requirements in the system, see figure 4.12, which shows the structure of these environments.

![Diagram of Instructor Environment]

**Figure 4.12: Instructor Environment.**

The main pages in this environment are:

1. **Instructor Profile**, this page presents the basic information about the instructor such as the name, the email and so on. The system allows the instructor to edit his/her information.

2. **Instructor Assess Students Page**, the system adopts multi entries for students’ model. One of these entries is the instructor’s assessments, and these assessment’s values are entered by slider or text field. The system
allows the instructor to assess all his/her students. This assessment’s values will be presented in the students’ model later on.

3. Instructor View Students Models, as mentioned earlier, the system adopts an open learner model in which that system allows the instructor to view his/her students’ models.

4. Instructor Manage Contents, the system allows the instructor to manage the content of his/her course, which includes concepts, questions and answers. The system allows the instructor to add, edit or delete these contents. In addition, the system allows the instructor to import or export the different contents from or to excel sheets, which simplify the process of adding contents as shown in figure 4.13.

**Questions Manager**

![Content Manager](image)

**Figure 4.13:** Content Manager.

---

4.2.3 Parents’ Environment

The parents have many requirements in the system; see figure 4.14 that shows the structure of this environment.
The main pages in this environment are:

1. **Parent’s Profile Page**, this page presents the basic information about the parents such as the name, email and so on. The system allows the parents to edit their information.

2. **Parents Assessing their Children Page**, the system allows the parents to assess their children. The assessment’s values are entered by slider or text field. This assessment’s values will be presented in the student model later on.
3. **Parent Viewing their children Models Page**, the system allows the parents to view the student model and find out how their children do.

### 4.3 Testing the System

The wide usage of the Internet gives us web application strategies and investment value, so that testing of the web application becomes a critical issue, and the testing of web application is the key of success. This section presents the suitable strategies, levels, and methodologies used in testing our system.

#### 4.3.1 Scope of Testing

The test plan (to test our system scope) includes the following:

1. Testing all functional requirements.
2. Testing all nonfunctional requirements.
3. End to end testing of UI of the system.

#### 4.3.2 Test Methodology

- **Performance Testing**
  
  To test the performance of our system we are going to use two tools. The first tool was developed by Microsoft, and it is embedded in the Visual Studio itself. The second tool is called WebPagetest, and it is an online and free tool.

- **Compatibility Testing**
  
  To test the compatibility, we are going to use two ways. The first way is by using WebPagetest tool. The second way is manually.
4.3.3 Testing Results

1. **Performance Testing Result** This results by using the WebPagetest tool as shown in figures 4.15, 4.16.

![Figure 4.15: WebPagetest result](image1)

![Figure 4.16: WebPagetest result2](image2)

2. **Portability Testing Result** This results done manually by browsing the system using a mobile device figures 4.17 and 4.18, present some snapshots.
Figure 4.17: Mobile snapshot 1

Figure 4.18: Mobile snapshot 2
Chapter 5

System Evaluation

This chapter presents an evaluation of the system from different points of view. (1) Evaluate the system against requirements. (2) Evaluate the system with comparison with some existing systems, and finally (3) evaluate the system from the users’ point of view.

5.1 Evaluation of the System Against System Requirements

All objectives announced at the beginning of this thesis have been achieved. The system was set up according to the functional and non-functional requirements. Students can now easily register in the system and take the system exam. In addition to assessing themselves, students can negotiate with the system about the level of knowledge. Also, any student can help others peers. The student himself can easily see the student model or he can allow his peers to have a look as well. The teacher can now register in the system, assess the students and see the student model as well as helping them. Furthermore, the teacher can manage the content of the knowledge by adding questions and answers. The parent can also register in the system and assess their children, view the student model and to provide assistance as well.
5.2 Initial Evaluation of the System by Users

In this section, the results of the evaluation from the users’ point of view will be shown. In our system, there are four main types of users: students, parents, instructors and supervisors. Therefore, we will give an evaluation result from all types of users.

5.2.1 Evaluation Strategy

We chose a group of 30 students, and gave them an exam from their instructor. After that, the students were divided into three groups; each group had 10 students. The instructor repeated the 5 concepts for the first group in the classroom. In the second group, the students applied the normal ITS (with system evaluation only). In the third group, the students tried our system with (multi entries). At the end, all students were given another exam from the instructor. The different results of our evaluation were due to the differences in the level of enhancement of the students in each group. See table 5.1 to show all the groups’ results.

5.2.2 Results Analysis

The results of all groups in table 5.1 show us Group1 (in which the students do not use the ITS). In this group, 60% of students improved, 10% fixed and 20% of them declined, as shown in the figures of tables 5.1 and 5.4. Whereas, Group2 in which the students use the classic ITS (with system exam only). In this group, 80% of the students improved, 20% fixed and no one declined, as shown in the figures of tables 5.2 and 5.4. Finally, Group 3 in which the students use our system (with multi entries). In this group, 90% of the students improved, 10% fixed and no one declined, as shown in the figures of tables 5.3 and 5.4.
### Table 5.1: All groups results

<table>
<thead>
<tr>
<th>Student#</th>
<th>Pre exam</th>
<th>Concept 1</th>
<th>Concept 2</th>
<th>Concept 3</th>
<th>Concept 4</th>
<th>Concept 5</th>
<th>Post exam</th>
</tr>
</thead>
<tbody>
<tr>
<td>G1St1</td>
<td>7</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>G1St2</td>
<td>8</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>G1St3</td>
<td>9</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>G1St4</td>
<td>10</td>
<td>5</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>G1St5</td>
<td>5</td>
<td>9</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>G1St6</td>
<td>9</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>G1St7</td>
<td>8</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>G1St8</td>
<td>7</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>G1St9</td>
<td>6</td>
<td>5</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>G1St10</td>
<td>5</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
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<td>6</td>
</tr>
<tr>
<td>G2St1</td>
<td>10</td>
<td>50</td>
<td>45</td>
<td>45</td>
<td>45</td>
<td>45</td>
<td>45</td>
</tr>
<tr>
<td>G2St2</td>
<td>9</td>
<td>50</td>
<td>45</td>
<td>45</td>
<td>45</td>
<td>45</td>
<td>45</td>
</tr>
<tr>
<td>G2St3</td>
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<td>20</td>
<td>15</td>
<td>15</td>
<td>15</td>
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<td>G2St4</td>
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<td>40</td>
<td>30</td>
<td>40</td>
<td>30</td>
<td>25</td>
<td>25</td>
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<td>15</td>
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<td>10</td>
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<td>25</td>
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</tr>
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<td>G2St7</td>
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<td>50</td>
<td>45</td>
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<td>50</td>
<td>50</td>
</tr>
<tr>
<td>G2St8</td>
<td>9</td>
<td>50</td>
<td>45</td>
<td>45</td>
<td>50</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>G2St9</td>
<td>8</td>
<td>45</td>
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<td>45</td>
<td>50</td>
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</tr>
<tr>
<td>G2St10</td>
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<tr>
<td>G3St2</td>
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<td>45</td>
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</tr>
<tr>
<td>G3St3</td>
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<td>35</td>
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<td>15</td>
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<td>15</td>
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<tr>
<td>G3St4</td>
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<td>50</td>
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</tr>
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<td>40</td>
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<td>40</td>
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<tr>
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<td>30</td>
<td>20</td>
<td>25</td>
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<td>40</td>
</tr>
<tr>
<td>G3St7</td>
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<td>35</td>
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<td>20</td>
<td>25</td>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td>G3St8</td>
<td>6</td>
<td>35</td>
<td>30</td>
<td>25</td>
<td>25</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>G3St9</td>
<td>10</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>50</td>
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<td>4</td>
<td>25</td>
<td>15</td>
<td>20</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
</tbody>
</table>

**Figure 5.1:** Group 1
Chapter 5. System Evaluation

Figure 5.2: Group 2

Figure 5.3: Group 3
5.2.3 Users Evaluation

A questionnaire was prepared to evaluate the system by users after using it, each user was asked to fill a questionnaire in which all users can express their opinion about the system. Using the results of the questionnaire, it is possible to evaluate the system and to add some modifications suggested by the users. These questions include:

Students’ questionnaire questions

1. The software was useful.

2. The software was interesting.

3. The software was easy to use.

4. Giving the student the option to explicitly choose a list of peers and instructors who can see his/her model was useful.

5. All individual models should contribute to the group model.

6. The information inside my model (feedback) was useful.
7. The system helped me to learn.

The figure 5.5 presents result of the analysis of the students’ questionnaire

![Students' Questionnaires](image)

**Figure 5.5: Student’s Questionnaire**

**Parents’ questionnaire questions:**

1. The software was useful.
2. The software was interesting.
3. The software was easy to use.
4. Giving the parents to browse their child’s model was useful.
5. The information inside child model (feedback) was useful.
6. The system helped me to help child.

The figure 5.6 presents result of the analysis of the Parents’ questionnaire

**Instructors’ questionnaire questions**

1. The software was useful.
2. The software was interesting.
3. The software was easy to use.
4. Giving me to browse their students’ model was useful.
Chapter 5. System Evaluation

Figure 5.6: Parents’ Questionnaire

5. The information inside student model (feedback) was useful.

The figure 5.7 presents result of the analysis of the instructors’ questionnaire

Figure 5.7: Instructor’s Questionnaire

Statistics from the Web Application

1. 100% of students viewed their models.

2. 100% of parents viewed their children’s models.

3. 30% of students opened their models for their peers.

4. 65% of students were in groups.

5. 35% of students had misconceptions.
6. 10% of students provided assistance to their peers

5.3 Final Evaluation of the System by Users

After we had accomplished the first analysis of the module and compared it with the two previous systems through a 30-student sample, there was an improvement in the level of students in favor of the module. However, this improvement was not substantially obvious or tangible due to the small sample. In this analysis, we used a 60-student sample divided into two groups: a group with a traditional learning system and a group with our model. Then, we followed these steps:

1. Choosing the 60-student sample A sample was randomly chosen according to the school official records for 185 students. 185/30, the answer was 6. We chose students 1, 6, 12 and so on as shown in figure 5.8. Then, we removed the selected names to choose the second ones in the same way. Finally, we had two groups with 30 students in each one.

2. A Pre-test We prepared a pre-test for the 60 students at the same level, and the results were gathered as shown in figure 5.9 for the first group, and in figure 5.10 for second group.

<table>
<thead>
<tr>
<th></th>
<th>Frequency</th>
<th>Percent</th>
<th>Valid Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Valid</td>
<td>4.00</td>
<td>3</td>
<td>16.0</td>
<td>10.0</td>
</tr>
<tr>
<td></td>
<td>5.00</td>
<td>2</td>
<td>6.7</td>
<td>6.7</td>
</tr>
<tr>
<td></td>
<td>6.00</td>
<td>3</td>
<td>16.0</td>
<td>10.0</td>
</tr>
<tr>
<td></td>
<td>7.00</td>
<td>7</td>
<td>23.3</td>
<td>23.3</td>
</tr>
<tr>
<td></td>
<td>8.00</td>
<td>10</td>
<td>33.3</td>
<td>33.3</td>
</tr>
<tr>
<td></td>
<td>9.00</td>
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<td></td>
<td>10.00</td>
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<td>3.3</td>
<td>3.3</td>
</tr>
<tr>
<td>Total</td>
<td>30</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Figure 5.9: Traditional Learning Group Pre-test Results
3. A Post-test The students in the first group received an explanation to the concepts using the traditional way, then they had the post-test, and the
results were recorded as shown in figure 5.11. Similarly, the students in the second group used the new system, then they had the post-test, and the results were also recorded as shown in figure 5.12.

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Percent</th>
<th>Valid Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
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<td>3.3</td>
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<tr>
<td>4.00</td>
<td>1</td>
<td>3.3</td>
<td>6.7</td>
</tr>
<tr>
<td>5.00</td>
<td>1</td>
<td>3.3</td>
<td>10.0</td>
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<tr>
<td>6.00</td>
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<td>6.7</td>
<td>16.7</td>
</tr>
<tr>
<td>7.00</td>
<td>4</td>
<td>13.3</td>
<td>30.0</td>
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<tr>
<td>8.00</td>
<td>7</td>
<td>23.3</td>
<td>53.3</td>
</tr>
<tr>
<td>9.00</td>
<td>11</td>
<td>36.7</td>
<td>90.0</td>
</tr>
<tr>
<td>10.00</td>
<td>3</td>
<td>10.0</td>
<td>100.0</td>
</tr>
<tr>
<td>Total</td>
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<td>100.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>

**Figure 5.11: Traditional Learning Group Post-test Results**

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Percent</th>
<th>Valid Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
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<td>6.7</td>
</tr>
<tr>
<td>7.00</td>
<td>1</td>
<td>3.3</td>
<td>10.0</td>
</tr>
<tr>
<td>8.00</td>
<td>5</td>
<td>16.7</td>
<td>26.7</td>
</tr>
<tr>
<td>9.00</td>
<td>10</td>
<td>33.3</td>
<td>60.0</td>
</tr>
<tr>
<td>10.00</td>
<td>12</td>
<td>40.0</td>
<td>100.0</td>
</tr>
<tr>
<td>Total</td>
<td>30</td>
<td>100.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>

**Figure 5.12: New Model Group Post-test Results**

4. The Hypotheses

1. No statistically significant differences between the two groups in the pre-test.
2. No statistically significant differences in the first group between the pre-test and the post-test.
3. No statistically significant differences in the second group between the pre-test and the post-test.
4. No statistically significant differences between the two groups in the post-test.
5. The Paired T-Test for groups:

1. The T test was applied to prove the first hypothesis, and the results were as shown in figure 5.13. It means that both groups were converged without any significant differences. Thus, the hypothesis is correct.

![Paired Samples Statistics]

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>N</th>
<th>Std Deviation</th>
<th>Std Error Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>pre_traditional</td>
<td>7.4667</td>
<td>30</td>
<td>1.57750</td>
<td>.28801</td>
</tr>
<tr>
<td>pre_lts</td>
<td>7.0007</td>
<td>30</td>
<td>1.55567</td>
<td>.29138</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Correlation</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>pre_traditional &amp; pre_lts</td>
<td>30</td>
<td>.283</td>
<td>.150</td>
</tr>
</tbody>
</table>

![Paired Samples Test]

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Std Deviation</th>
<th>Std Error Mean</th>
<th>Low of 95% Confidence Interval of the Difference</th>
<th>Upp of 95% Confidence Interval of the Difference</th>
<th>t</th>
<th>df</th>
<th>Sig (2-tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>pre_traditional</td>
<td>7.4667</td>
<td>1.57750</td>
<td>.28801</td>
<td>-1.6</td>
<td>1.78</td>
<td>29</td>
<td>29</td>
<td>.775</td>
</tr>
<tr>
<td>pre_lts</td>
<td>7.0007</td>
<td>1.55567</td>
<td>.29138</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 5.13: Compared the Two Groups of Pre Test Results

2. The T test was applied to prove the second hypothesis, and the results were as shown in figure 5.14. It means that the hypothesis was incorrect, and there is an improvement in favor of the post-test.
3. The testing of the third hypothesis is in the following figure 5.15. We found that the hypothesis was incorrect since there was a slight improvement in favor of the post-test, which means that the new module has improved the level of the students.

Figure 5.14: Compared the traditional group of Pre and post Test Results

<table>
<thead>
<tr>
<th>Paired Samples Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>pre_traditional</td>
</tr>
<tr>
<td>post_traditional</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Paired Samples Correlations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>pre_traditional &amp; post_traditional</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Paired Samples Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paired Differences</td>
</tr>
<tr>
<td>pre_traditional-post_traditional</td>
</tr>
</tbody>
</table>

Figure 5.15: Compared our model group of Pre and post Test Results

<table>
<thead>
<tr>
<th>Paired Samples Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>pre_ts</td>
</tr>
<tr>
<td>pos_ts</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Paired Samples Correlations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>pre_ts &amp; pos_ts</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Paired Samples Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paired Differences</td>
</tr>
<tr>
<td>pre_ts-pos_ts</td>
</tr>
</tbody>
</table>
4. The results of the fourth hypothesis were as the following figure 5.16. It was found that the hypothesis was incorrect, and the post-test of the new module was better than the post-test in the traditional learning.

<table>
<thead>
<tr>
<th>Paired Samples Statistics</th>
<th>Mean</th>
<th>N</th>
<th>Std. Deviation</th>
<th>Std. Error Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pair 1: post_traditional</td>
<td>7.8657</td>
<td>30</td>
<td>1.81437</td>
<td>.33126</td>
</tr>
<tr>
<td>post_traditional</td>
<td>8.9657</td>
<td>30</td>
<td>1.15917</td>
<td>.21163</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Paired Samples Correlations</th>
<th>N</th>
<th>Correlation</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pair 1: post_traditional &amp; post_trad</td>
<td>30</td>
<td>.195</td>
<td>.303</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Paired Samples Test</th>
<th>Paired Differences</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Std. Error Mean</th>
<th>95% Confidence Interval of the Difference</th>
<th>t</th>
<th>df</th>
<th>Sig (2-tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pair 1: post_traditional - post_trad</td>
<td>-1.1005</td>
<td>1.9337</td>
<td>3.5671</td>
<td>-1.82955</td>
<td>-3.7045</td>
<td>29</td>
<td>.004</td>
<td></td>
</tr>
</tbody>
</table>

Figure 5.16: Compared the traditional and our model in post Test Results

5.4 Discussion

The increase in the sample size has clearly affected the final results, and it proved that the module had a clear positive influence on improving the students. The module showed that it was more superior comparing with traditional learning systems. The first null hypothesis was to prove that both random groups had no significant differences, and they were equal. This showed some credibility in the results. The second hypothesis was to examine the students’ progress if there was any through applying the traditional learning system and observing the students’ level. The results showed that the students were improved after applying the traditional learning system, but it was a slight increase. In addition, the system was not able to determine the students’ problems or their misconceptions, and it did not consider the individual differences between students. This has had a negative impact that caused the lack of progress between students. The third hypothesis
was to test the students’ progress between the pre-test and the post-test after applying the new module. The results have shown a clear improvement with the students after applying the module. Furthermore, the new module dealt with each student separately and it determined his/her misconceptions. The module has also included the students’ parents and instructors in the learning process, and that has greatly improved the students’ level. The fourth hypothesis was to test the level of superiority between the new module and the traditional learning system. The results have demonstrated a significant superiority and a clear improvement with the students who used the module comparing with the other group. Moreover, they were more motivated, more interactive, more confident and better in accepting their results.

5.4.1 The Mechanism of Evaluating and Testing

The pre-test and post-test are regular paper tests for both groups. However, the difference is in re-explaining the material for the students in the first group: the five concepts were re-explained in a 40-minute class for all students in a real classroom. Regarding the second group, the students were only taught the misconceptions which were recorded for them. Here, I’d like to provide an example: Student 12 was weak in the pre-test concerning the concept of call forwarding to switchboards, which I mentioned previously as an example. The student’s final evaluation was 10/50. Therefore, this concept was repeated to him in less than 5 minutes, and he got full mark for this concept in the post-test was. We notice the difference in time and effort for the teacher to make the idea clear to students in short time with a huge difference in the results. We conclude here that the advantage of the system is not only the difference in results but also the time and effort given to restore the student’s information effectively.
5.4.2 Some Notes

1. We had a major problem in applying the system with parents because it was not easy to communicate with them and convince them to be honest in what concerned the educational level of their children and their needs. The parents tended to overestimate that the educational level of their children was good. Therefore, we held meetings with them, and we explained that knowing the real level of their children would help to improve them in future.

2. There was an excellent acceptance between young teachers to the idea and they were enthusiastic to apply it on the contrary with the old and traditional teachers who did not know how to use a computer. However, the rate of young and open-minded teachers is increasing and they would like to change the traditional learning pattern.

5.4.3 Recommendations

I can say that the concluded results led us clearly to create an integrated portal with this idea and try to apply it in reality and to adopt this idea in order to raise the educational level in general. In addition, we can try to accomplish the main objectives such as involving the parents in the educational process as well as the student himself/herself, and that will have a positive impact on their academic achievements later.

5.5 Evaluation of the System with Reference to Similar Systems

In this section, we’ll show a comparison between the student model in our system and in other systems:

1. German Tutor: It is an intelligent language tutoring system to learn German grammar [37], the main features in this system are as the following: it is a
full intelligent tutoring system, it supports open learner model, and there are three levels to learn German grammar (Beginners, Intermediate, and Advanced). In the other hand, the system does not allow the instructors or peers to see the student model, and it does not support the groups, also the student model presents the level of the student textually only as shown in see figure 5.17.

![Figure 5.17: Student Model- German Tutor](37)

2. SQL-Tutor: It is an intelligent educational system to learn structured query language (SQL) [38]. The main features in this system are as the following: it’s a complete intelligent tutoring system, it is specially developed for university-level students only, it supports the open learner model, and the student model presents a textual and graphical information, see figure 5.18. In the other hand, the system does not allow the instructors or peers to see the student model, and it does not support the groups.

![Figure 5.18: Student Model- German Tutor](38)

3. Duolingo: It is an intelligent language tutoring system to learn 8 different languages [39]. The main features in this system are as the following: it
Table 5.2: The main differences between our system and the three systems

<table>
<thead>
<tr>
<th>#</th>
<th>System</th>
<th>Open</th>
<th>Group</th>
<th>Peers and Instructor</th>
<th>entries</th>
<th>Complete</th>
<th>Content</th>
<th>Student Model</th>
<th>Negotiable</th>
<th>Collaborative</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>German Tutor</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Pre test</td>
<td>Yes</td>
<td>German Grammar</td>
<td>textual</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>2</td>
<td>SQL-Tutor</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Pre test</td>
<td>Yes</td>
<td>SQL</td>
<td>Textual &amp; Graphical</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>3</td>
<td>Duolingo</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Pre test</td>
<td>Yes</td>
<td>8 Languages</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>4</td>
<td>Our system</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>4 Different Entries</td>
<td>No</td>
<td>Any thing</td>
<td>Textual &amp; Graphical</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Table 5.2 shows a summary of the main differences between our system and the three systems.
5.5.1 Threats to Validity

The students’ sample of the experiment was relatively small (30 students). Until the results are accurately certified, it should be carried out with larger number of students. Moreover, the experiment is confined to the category of students whose parents want them to participate in the system, and it’s confined to a limited age category (10th grade). Finally, it is confined to a relatively few concepts (only five).
Chapter 6

Conclusion and Future Work

This chapter presents in section 6.1 the main conclusions about the thesis. Then section 6.2 shows suggestion for future work.

6.1 Conclusion

The accuracy of the student model is the criterion of the adequacy of the whole intelligent tutoring system ITS. Therefore, we make sure to achieve the best possible accuracy with the student model through entering new resources to the model. These resources are based on allowing the student to evaluate himself in addition to the evaluation of his teacher, parents and the system. This will contribute in achieving bigger accuracy, it will also give the student more desire towards learning because he becomes involved in it as well as his parents who will pay more attention to their child and will enhance him to learn better. The system, which was done to improve the student model, relied on the Open Student Model which depends on revealing what the system thinks about the student to the student himself, or anyone who is chosen by the student from his peers and friends. The student is also allowed to negotiate the system about his knowledge level, and he can try to change what the system thinks about his level through other tests that the student can perform to prove his success. Finally, we evaluated the system
through two experiments. The first one used (30 students) and with their parents and instructors. The results have shown that our system can improve a student level and enhance his / her motivation for learning, but this experience did not achieve statistical results are clear. The second experiment used (60) students. In this experiment we get a better results because of the larger sample, and we can prove statistically significant improvement among students for the benefit of the new model. In addition, we are able to integrate the parents in the educational process and make them more informed about the educational level of their children. In the other hand, the instructor feels that his / her experience has invested appropriately; moreover, he / she is not neglected as he / she is an indispensable part in the educational process.

6.2 Future Work

In the future, there are many things to work on regarding this system:

1. Create a system, which reads and analyzes the student model, provides scientific and educational proposals for the student, and offers these suggestions for the student himself, teacher and parents.

2. Add the psychological aspect of the student, which requires action by sensors. They can be connected to the student to analyze the psychology of behavior during the using of the system.

3. Include the students activities and their interaction with the data mining algorithm which will decide later on the extent of the forces of student interaction with the system and the extent of improvement in the educational level of the student.
Bibliography


Appendix A

Questionnaires
A.1 Message Directorate of Education for schools

Figure A.1: Message Directorate of Education for schools.
A.2 Students Questionnaire

Figure A.2: Students Questionnaire Page 1.
## أسئلة خاصة بتقييم الطالب لنفسه

1. باسالي تحديد احتياجاتي التعليمية بنفسه بشكل دقيق.
2. قدرتي على تحديد احتياجاتي التعليمية بشكل دقيق.
3. أنا قادر على تحديد احتياجاتي في إختياراتي.
4. تستطيع تحديد نقاط ضعفي في موضوع معي.
5. تستطيع تحديد نقاط ضعفي في موضوع معي بشكل دقيق.
6. استطيع مساعدة معلمي / معلمتي في تحديد احتياجاتي.
7. أستطيع تحديد نقاط ضعفي في موضوع معي.
8. أستطيع تحديد نقاط ضعفي في موضوع معي بشكل دقيق.
9. أستطيع تحديد نقاط ضعفي في موضوع معي.
10. أستطيع تحديد نقاط ضعفي في موضوع معي بشكل دقيق.

## أسئلة خاصة بتقييم المعلم للمتعلم

11. معلمي / معلمتى يساعدوني في تحديد احتياجاتي التعليمية بشكل دقيق.
12. معلمي / معلمتى يساعدوني في تحديد احتياجاتي التعليمية بشكل دقيق.
13. معلمي / معلمتى يساعدوني في تحديد احتياجاتي التعليمية بشكل دقيق.
14. معلمي / معلمتى يساعدوني في تحديد احتياجاتي التعليمية بشكل دقيق.
15. معلمي / معلمتى يساعدوني في تحديد احتياجاتي التعليمية بشكل دقيق.
16. معلمي / معلمتى يساعدوني في تحديد احتياجاتي التعليمية بشكل دقيق.

## أسئلة خاصة بتقييم أولياء الأمور للطالب (ولي الأم : أب، أم، أخ، أخت...)

16. يستطيع ولي أمرى تحديد احتياجاتي التعليمية بشكل دقيق.
17. يستطيع ولي أمرى تحديد احتياجاتي التعليمية بشكل دقيق.
18. يستطيع ولي أمرى تحديد احتياجاتي التعليمية بشكل دقيق.
19. يستطيع ولي أمرى تحديد احتياجاتي التعليمية بشكل دقيق.
20. يستطيع ولي أمرى تحديد احتياجاتي التعليمية بشكل دقيق.

## أسئلة مفتوحة

21. حسب وجهة نظرك ما هي النسبة المئوية في الاعتماد على تحديد احتياجاتي في كل من:
   - % احتياجاتي
   - % تقييمي
   - % تقييمي
   - % تقييمي
   - % نظري

   المجموع: 100%

22. ما هي المرحلة الدراسية التي يمكن للطالب / بنت تقييم فيها نفسه؟

23. هل ترغب بالمشاركة بنظام يعتمد مثل هذه الأساليب في التقييم؟

---

Figure A.3: Students Questionnaire Page 2.
A.3 Teachers Questionnaire

استبيان حول تقييم الطالب
(خاص بالمعلمين)

يعتبر التقييم للطالب أهم أجزاء لأي نظام تعليمي سواء أكان في المراكز التعليمية في الواقع كالمدارس والجامعات أو حتى في النظم الإلكترونية للتعليم من خلال شبكة الإنترنت أو غيرها. وثباته مهم لأنه يعني موفرًا لمسيرة الطالب/ة في موضوع معين، وبالتالي إمكانية تحديد الاستراتيجيات التربوية المناسبة له/ا. يبد أن الاعتماد الكبير في الحصول على تقدير نقي للطالب هو الامتحان، لكن نحن نريد أن نبحث عن مداخل أخرى للتقييم كتقييم الطلاب نفسه، وتقييم المعلم له، وتقييم أولاء الأmetry كذلك.

هذه الاستبيان سري، فرجو عدم كاتب اسمك عليها أو التكيف عن هو بيك. وتجمع الاجابة مع استجابات الآخرين من خلال عملية لا تسمح بالتعرف على أي شخص. وسنستخدم خلاصة الأراء لتطوير نظام تعليمي نتigli بهدف أن يحن أكثر من مدخل في تقييم الطلاب للوصول إلى تقييم أكثر دقة للطالب.

نرجو التفضيل بالإجابة عن الأسئلة التالية بوضع اشارة X في المكان الصحيح.

إعداد المعلم: علي أحمد عبد الرحيم الجدع  
مشرف رسالة الماجستير: د. عبد اللطيف أبو عيسى

لا أوافق بشدة
لا أوافق
صحيح لحد ما
أوافق
أوافق بشدة

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الأسئلة خاصة بالامتحانات

1. أطلق أن الامتحانات كافية لتحديد أهداف الطالب التعليمية.
2. أن نتفرقت مداخل أخرى لتحديد الامتحانات إضافة للامتحانات سيكون أفضل.
3. الامتحانات هي أدق وسهولة للتميز بين الطلبة.
4. لا أقف بنظير الامتحانات للدراة العلمية.

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برنامج الماجستير في الحوسبة

Figure A.4: Teachers Questionnaire Page 1.
Appendix A. Questionnaires

Figure A.5: Teachers Questionnaire Page 2.
**A.4 Parents Questionnaire**

استبيان حول تقييم الطالب

 يعتبر التقييم للطلاب أحد أجزاء نظام تقييم الطلبة في المراكز التعليمية في الواقع كالمدارس والجامعات، وحتى في النظام الأكاديمي للتعليم من خلال شبكة الإنترنت. والتحقيق مهم لأنه يعطي موجزاً لمستوى معرفة الطالب/ة في موضوع معين، وبالتالي إمكانية تحديد الاستراتيجيات التربوية المناسبة له/ها. يبدأ في الأعداد الكبير في الحصول على تقييم نهائي للطالب، وهو الامتياز. لكن نحن نريد أن نبتقي في للطلاب أو الأمور كذلك.

أولاً: هذه الاستبانة سرية، فرجع عدم كتابة اسمك عليها أو التأكد من هوية. وتجمع استجابتك مع استجابات الآخرين من خلال عملية لا تعتمد بالتعرف على أي شخص، ونستخدم خلاصة الأراء للتطوير نظام التعليم الذي يعد على أكثر من مدخل في تقييم الطلاب للوصول إلى تقييم أطراف للطالب.

نتوجه النافذة بالإجابة عن الأسئلة التالية بوضع اشارة \( \times \) في المكان الصحيح.

**إعداد المعلم: علي أحمد عبد الرحيم الجدع، مشرف رسالة الماجستير: د. عبد اللطيف ابو عيسى**

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<th>لا أوافق بشدة</th>
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<td>1.</td>
<td>(أوافق بشدة) تعني أن العبارة صحيحة دائماً أو في كل الأحيان تقريباً، أو أن المطلوب تم تأديته بشكل جيد. (وافق) تعني أن العبارة غالبًا أو في أغلب الأحيان، أو أن المطلوب تم تأديته بشكل جيد تقريباً. (صحيح لحد ما) تعني أن المطلوب تم تأديته بشكل متوسط. (لا أوافق) تعني أن المطلوب تم تأديته بشكل ضعيف أو لم يوجد في معظم الأحيان. (لا أوافق بشدة) تعني أن المطلوب لم تأتني بشكل سيء جداً، أو لم يوجد أصلاً، أو نادراً ما تأتي.</td>
<td>(أوافق بشدة)</td>
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<td>صحيح لحد ما</td>
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**Figure A.6: Parents Questionnaire Page 1.**
### أسئلة خاصة بتقييم الطالب لنفسه

1. أعتقد أن الطالب يمكنه تحديد احتياجاته التعليمية لنفسه بشكل ما.
2. يساعدني الطالب في تحديد احتياجاته.
3. هناك رغبة من الطلاب عن إدراهم في اخبار امتحانات تقدموا لها.
4. تحديد الطلاب لاحتياجاتهم لنفسه أفضل من تقييم الامتحان له.
5. يستطيع الطالب تحديد نقاط ضعفه.
6. يساعد الامتحان الطلاب في اكتشاف نقاط ضعفه.

### أسئلة خاصة بتقييم المعلم للطالب

1. يستطيع تحديد احتياجات طلبه بشكل دقيق.
2. يساعد المعلم طلبه في تحديد مستواهم.
3. يساعد المعلم طلبه لتخفيض مشكلاتهم الدراسية.
4. يراعي المعلم الفروق الفردية بين طلبه.
5. يختار المعلم الطرق الدراسية المناسبة لكل فئة من الطلبة.
6. يستطيع المعلم نقل مستوى طلبه لأولياء الأمور بشكل دقيق.

### أسئلة خاصة بتقييم أولياء الأمور للطالب

1. يستطيع تحديد احتياجات الطالب بشكل دقيق.
2. يساعد الطالب في تحديد مستواه.
3. يرشد الطالب لتخطي مشكلاتهم في الدراسة.
4. يستطيع نقل مستوى الطالب للمعلم.
5. يستطيع نقل مستوى الطالب للمعلم.

### أسئلة مفتوحة

26. ما هي المرحلة الدراسية التي يمكن للطالب / بنت تقييم فيها نفسه؟

27. هل ترغب بالمشاركة بنظام يعتمد مثل هذه الأساليب في التقييم؟

---

**Figure A.7:** Parents Questionnaire Page 2.
Appendix B

Feasibility Study
B.1 Students Data

B.1.0.1 Student Data Collection Section A

A1

- Strongly Disagree: 16%
- Disagree: 26%
- Impartial: 11%
- Agree: 53%
- Strongly Agree: 0%

A2

- Strongly Disagree: 21%
- Disagree: 32%
- Impartial: 10%
- Agree: 26%
- Strongly Agree: 11%
B.1.0.2 Student Data Collection Section B

B1

Strongly Disagree
Disagree
Impartial
 Agree
Strongly Agree
26%
26%
16%
11%
0%
47%

B2

Strongly Disagree
Disagree
Impartial
 Agree
Strongly Agree
21%
16%
16%
0%
47%

B3

Strongly Disagree
Disagree
Impartial
 Agree
Strongly Agree
26%
21%
5%
16%
32%
B.1.0.3 Student Data Collection Section C

**C1**
- Strongly Disagree: 5\%
- Disagree: 0\%
- Impartial: 16\%
- Agree: 37\%
- Strongly Agree: 42\%

**C2**
- Strongly Disagree: 16\%
- Disagree: 0\%
- Impartial: 16\%
- Agree: 5\%
- Strongly Agree: 63\%

**C3**
- Strongly Disagree: 21\%
- Disagree: 0\%
- Impartial: 11\%
- Agree: 26\%
- Strongly Agree: 42\%
B.1.0.4 Student Data Collection Section D

D1

- Strongly Disagree: 28%
- Disagree: 11%
- Impartial: 21%
- Agree: 42%

D2

- Strongly Disagree: 21%
- Disagree: 5%
- Impartial: 11%
- Agree: 47%

D3

- Strongly Disagree: 5%
- Disagree: 26%
- Impartial: 16%
- Agree: 69%
Appendix B. Pedagogical Analysis

B.1.1 Students Responsive

Group A

Group B

Group C