# Professor SMILE Leads the Way to a New Dawn for Information and Communication Technology Education

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## ABSTRACT

*Enormous motivation is required from students just to cope with the material, let alone learn from Traditional IT courses. It was not surprising, therefore, to find in four classroom studies in UGRU that only 37% students want to learn IT using traditional methods. Understanding the situation, in spring 2005 UGRU introduced a new ICT program. Still it is not enough. Different students have different styles and strategies of learning. Recognising this fact, we strongly believe that simulations can be an effective counter to many of the aforementioned issues while also providing equal opportunities to men and women in higher education in the Arab World. Professor SMILE (SiMulated Integrated Learning Environment), an intelligent, critical and creative thinker, can help the future generation learn ICT effectively.*

## 1. INTRODUCTION

Teaching and learning in Higher Education in the United Arab Emirates have recently undergone a major paradigmatic shift, from the traditional format to one in which students are actively engaged in their own learning process. This is true for IT as well as other subjects. While core values that are central to Islamic beliefs are retained, the methodology now focuses on teaching curriculums based on thinking, rather than rote memorization.

In spring 2005, the University General Requirements Unit (UGRU) of the United Arab Emirates University (UAEU), replaced the traditional Information Technology (IT) curriculum with a new Information and Communication Technology (ICT) curriculum. Evaluation of the new ICT curriculum, in terms of educational goals, content, teaching methods and assessment, revealed the following facts. The UGRU lecturers find the new ICT curriculum better than the traditional curriculum in all these areas. In particular, it integrates thinking skills into the technologically oriented curriculum. On the other hand, evaluation showed that there still remains much to be done to achieve objectives. There is a widening gap between present and future Information Technology (IT), taught in higher education, and the real use of IT. Educators are confused and students are bewildered by this. We strongly believe that simulations can be an effective way of narrowing this gap. This research paper will also focus on the usage of case-study based intelligent simulation technology in higher education. Particular emphasis would be given to its pioneering implementation within the UAE University's UGRU program.

Professor SMILE[1] is an innovative, intelligent, robust and ubiquitous computer system created to teach ICT to students in higher education. Its implementation is object oriented, and it incorporates a Discrete Event Simulation (DES) shell. Its design also makes it available on internet, mobile systems, and adaptable for the use of disabled persons. It can be used to teach Mathematics, English, Arabic, Science, Engineering and IT courses. It is a versatile system which can be upgraded to teach most of the things a human being can teach.

### 1.1 Prelude

First let us understand and analyze creativity, communication, collaboration, environment, and the human brain. Perhaps we should begin with a more basic question: what do we mean by creativity? The basis of creativity is achieving something that did not exist previously, breaking down established patterns, seeing things in a new way. But what drives people to think of something new? How does the creative process work? The creative process may manifest itself in different ways. "Chance favors the prepared mind," the famous scientist Louis Pasteur once said. Pathologist Peyton Rouse spoke likewise of "a prepared mind making its own chances." Are we going to prepare our students using new tools of information technology for future and using creative and critical thinking, value of good communication, and habits of collaboration or waiting for the chances[1]?

Several influences have converged to create a new emphasis on the teaching of a thinking skills based IT curriculum around the world. Prominent among these are workplace readiness and the constructivist movement[2]. Although education in the Arab nations was tied to religious fundamentalism during the 20th century and traditional teaching techniques relied primarily on rote learning within a lecturer-centered, religious-oriented context, teaching thinking in IT is not at all antithetical to the Holy Qu'ran. In fact, more than 640[2] verses in the Holy Qu'ran challenge believers to use their minds for critical thinking, problem-solving, creative thinking, and decision-making. In the 21st century, it is particularly important to cultivate these skills to enable our youth to function effectively in their own world as well as in the global community[3]. The new ICT curriculum focuses on critical and creative thinking. Perkins[5] notes six basic priorities for lecturers who actively teach for understanding rather than for memorization. Cognitive research and theory has changed the way many in the education system think about educational practice, including curriculum design, assessment, and learning environments. Greeno, Collins, and Resnick[6] emphasize that the design of learning environments can support cognitive or brain-based learning. Brooks and Brooks[4] describe several of these. For example, students need to be provided with curriculum holistically, emphasizing large concepts, rather than the fragments, or basic skills as building blocks that is typically the current approach[7]. These skills are used intelligently in the new ICT curriculum.

## 2. REASONS FOR BIRTH OF PROFESSOR SMILE

Some of the reasons for the birth of Professor SMILE are as follows: (i) There is a gap in present and future Information Technology (IT), taught in higher education, and real use of IT. (ii) Educators are confused and students are bewildered about IT programs in higher education. (iii) Traditional IT courses require enormous motivation to go through the material, let alone learn from it. (iv) Serious concerns can be raised regarding gaining relevant knowledge or developing required skills through traditional approach. (v) Different students have different styles and strategies of learning.

It was surprising to find in four classroom studies that not more than 37% students in UGRU want to learn IT using traditional methods. The rise of affordable computers and the internet have made IT learning ubiquitous. Yet much of what is offered under the guise of e-learning completely fails to make use of the essential features of either the computer or the Internet. More often than not the computer is used as little more than a television or a post box. Attempts to address

*Table 1. IT students' likes, dislikes, and suggestions about classes, courses, and teachers*

| Likes/ Dislikes | Art | | Business | | Science | | Total | |
|---|---|---|---|---|---|---|---|---|
| | Yes % | No % | Yes % | No % | Yes % | No % | Yes % | No % |
| I want to use internet instead of books from library for writing my research (papers/projects). | 94.87 | 5.13 | 100.00 | 0 | 80.95 | 19.05 | 91.55 | 8.45 |
| I want to use computer (blackboard programs, etc.) for learning in class not a teacher. | 41.03 | 58.97 | 36.36 | 63.64 | 38.10 | 61.91 | 39.44 | 60.56 |
| I want to take exams by using computer not on paper. | 53.85 | 43.59 | 54.55 | 45.46 | 71.29 | 28.71 | 60.56 | 39.44 |
| I want to study in a government university not in a private university. | 69.23 | 30.77 | 90.91 | 9.09 | 90.48 | 9.52 | 78.87 | 21.13 |
| I want to have higher education only for excellent students. | 41.03 | 58.97 | 45.46 | 45.46 | 42.86 | 57.15 | 42.25 | 57.75 |
| I want to have no exam, only project work, home work and quizzes to promote students to the next class. | 61.54 | 38.46 | 54.55 | 45.46 | 52.38 | 47.62 | 57.75 | 42.25 |
| I want to study to increase my knowledge other than for passing the Examination. | 66.67 | 33.33 | 72.73 | 18.18 | 71.29 | 28.71 | 69.01 | 30.99 |
| I do not like teachers who always ask me to come on time to the class | 56.41 | 41.03 | 54.55 | 45.46 | 42.86 | 57.14 | 53.52 | 46.48 |
| I do not like teachers who always keep me busy in studies whole period. | 74.36 | 23.08 | 45.46 | 54.55 | 52.38 | 47.62 | 64.79 | 35.21 |
| I want to eat and drink in the class while studying. | 61.54 | 38.46 | 63.64 | 36.36 | 57.14 | 42.86 | 60.56 | 39.44 |
| I do not want to come to class on Wednesday. | 79.49 | 17.95 | 54.55 | 45.46 | 61.91 | 38.10 | 71.83 | 28.17 |
| I want to talk with my friends in the class even when my teacher is teaching. | 35.90 | 56.41 | 27.27 | 72.73 | 33.33 | 61.91 | 36.62 | 63.3 |
| I do not like teachers who want me to do more study in class to get good marks but no rest. | 43.59 | 53.85 | 63.64 | 36.36 | 42.86 | 57.15 | 47.89 | 52.11 |
| I like that teacher who wants me to do very little study in class and gives more free time. | 48.72 | 51.28 | 27.27 | 72.73 | 38.10 | 57.14 | 43.66 | 56.34 |
| I feel angry with teachers who give me low marks even my work is poor. | 56.41 | 41.03 | 63.64 | 36.36 | 38.10 | 57.14 | 53.52 | 46.48 |
| I always want good marks in exam whether I study or not. | 66.67 | 33.33 | 36.36 | 63.64 | 42.86 | 57.14 | 54.93 | 45.07 |
| I like Arabic songs and Dances. | 56.41 | 38.46 | 27.27 | 72.73 | 42.86 | 57.14 | 49.30 | 50.70 |
| I want to sing in my free time. | 51.28 | 43.59 | 54.55 | 45.46 | 57.14 | 42.86 | 54.93 | 45.07 |
| I want to dance in my free time. | 43.59 | 51.28 | 45.46 | 54.55 | 33.33 | 66.67 | 42.25 | 57.75 |
| I like to play games (indoor/outdoor) more than studies. | 53.85 | 46.15 | 36.36 | 63.64 | 57.14 | 42.86 | 52.11 | 47.89 |

this situation by making instruction interactive typically fall short, in part for the same reasons, but also because of a failure to understand what is essential about interactivity[8].

We strongly believe that simulations can be an effective counter to many of the aforementioned issues. In fall 2004, research was conducted by the authors of this paper in classrooms of UAE University to find IT students' likes, dislikes, and suggestions about classes, courses, and teachers. The results are summarized in Table 1.

According to Harvard professor Dr. Howard Gardner in his multiple intelligence theory, students generally exhibit strength and weaknesses across the following types of learning methods: (i) A linguistic learner (excels at words); (ii) A logical learner (excels at numbers); (iii) A spatial learner (excels at visualizing); (iv) A musical learner (excels at music); (v) A kinesthetic learner (excels at physical activity); (vi) An interpersonal learner (excels at relationships); (vii) An intrapersonal learner (excels at working alone); (viii) A naturalistic intelligence; or (ix) An intelligence existential[9]. Our research about learning styles and strategies about UAE University students revealed interesting outcomes. The results are summarized in Table 2. All the earlier reasons are instrumental in the birth of Professor SMILE, an intelligent system to teach ICT to students of higher education. The capabilities of Professor SMILE are enormous, which future generation of learners will appreciate.

## 3. ARRIVAL OF PROFESSOR SMILE: A NEW INTELLIGENT SYSTEM

The prototype of Professor SMILE was developed using state of the art techniques of software engineering. The system architecture is open and object oriented. It uses rule based (both forward and backward chaining) reasoning at present with a facility to attach neural computing based artificial intelligence and DES modules which have been tested separately.

### 3.1 Design, Development Stages and Software Engineering Life Cycle

For the development of any simulator there are six main stages. Figure 1 shows a high-level view of the activities required to produce a system in terms of the stages that a system goes through. The development of Professor SMILE has gone through the three stages and the fourth is continuing. We used the classic

*Table 2. Learning styles and strategies of some ICT students*

| How do You want to learn ICT? | Number of Students | % of Students |
|---|---|---|
| By words (A linguistic learner) | 3 | 2.57 |
| By Pictures (A spatial learner) | 21 | 17.95 |
| By Doing Step by Step (A logical learner) | 20 | 17.09 |
| By Music (A musical learner) | 7 | 5.98 |
| By Moving or Dancing (A kinesthetic learner) | 13 | 11.11 |
| By working alone (An intrapersonal learner) | 24 | 20.51 |
| By working in a group (An interpersonal learner) | 29 | 24.79 |
| Total | 117 | 100 |

*Figure 1. Design and development stages used for Professor SMILE*

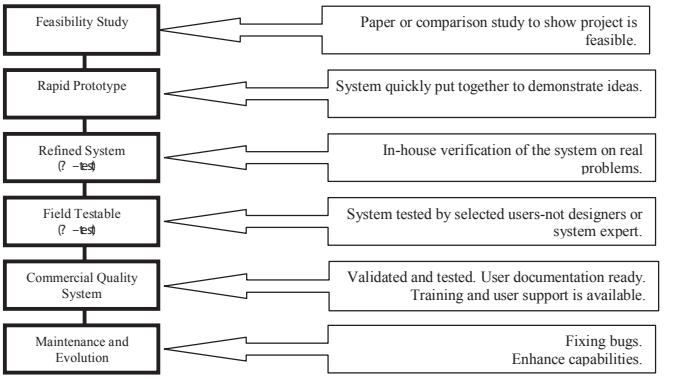
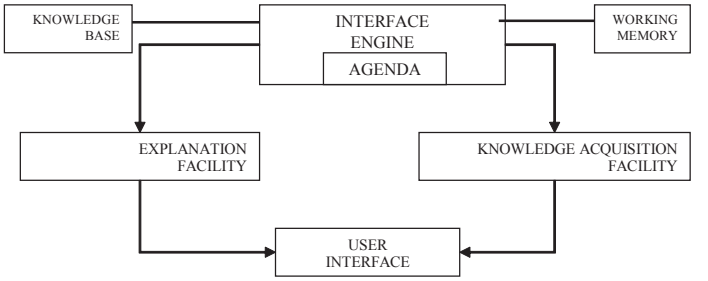



*Figure 2. A rule-based expert system mechanism that has been used in design of Professor SMILE*




waterfall model for development of software modules to be incorporated with Professor SMILE. In the waterfall model each stage ends with a verification and validation (V & V) activity to minimize any problem in that stage. Also, notice that the iterations go back and forth only one stage at a time. This represents the iterative development between two adjacent stages in order to minimize the cost compared to the higher cost of iterating development over several stages. The main design is "Event Driven. The system is capable of generating "Brain Map" for the problems it encounters.

**3.2 Technology**

Some of the components are as follows: (i) Visual Basic Version 6.0; (ii) Speech to Text and Text to Speech conversion: SAPI 5.1 (Microsoft); (iii) Use of Agent: CSAgent (Microsoft); and (iv) Expert Systems, Neural Computing , and DES Model. (v) *Computer Systems:* Windows XP, Windows 2000, and Windows NT. (vi) *Portability:* Linux and UNIX after converting VB code to any other language.

*3.2.1 Artificial Intelligence (AI) Module*

The expert system module of Professor SMILE uses forward and backward chaining in its design. We have a future plan to incorporate neural computing and DES modules with expert system. Figure 2 shows a Rule-based Expert System mechanism. In a rule-based system, the inference engine determines which rule antecedents, if any, are satisfied by the facts. Two general methods of inferencing are commonly used as the problem-solving strategies of expert system: forward chaining and backward chaining[10].

**3.3 Future Plan For Professor Smile**

We will use Discrete Event Simulation (DES) Model in future. Any addition of a software module to Professor SMILE is very easy because its design philosophy is open software architecture. DES is where a "simulation model" of a system is created using the idea of: "Entity" flow. Some of the features of this model are as follows: (i) It can visualise the concepts/processes involved in designing and writing a program. (ii) It is object orientated visually. (iii) It has simple 2D animation to enhance visualisation of the processes. The area of DES application in academic education is new except for courses in simulation. Professor SMILE is first to use DES as a shell to help students visualize and animate the process flow of program development life cycle (PDLC), the main steps of a general algorithm and writing a program. It can be expanded to cover many other types of process we want to visualize in the academic world.

Another improvement will be application of Neural Networks with existing Rule Based Expert System. The designers of this project have a good expertise in prediction of learner outcome using neural networks. The connectionist approach [which applying neural networks] is based on the supervised or unsupervised learning paradigms [10]. But there are some situations, like in learning environment, where these paradigms cannot be used in isolation because scenario changes continuously. An artificial neural network functions by receiving a set of input facts, processing these facts, and then producing a set of values calculated from these facts[10]. The training of a network is important, which is the major distinction criterion for different neural networks. The neural networks used here are based on two different paradigms; supervised and unsupervised learning paradigms. In our case we are using back-propagation network. McCulloch-Pitts neurons are the basic units of neural networks, shown in Figure 3(a). The basic

*Figure 3. (a) An artificial neuron, and (b) a back-propagation Net*

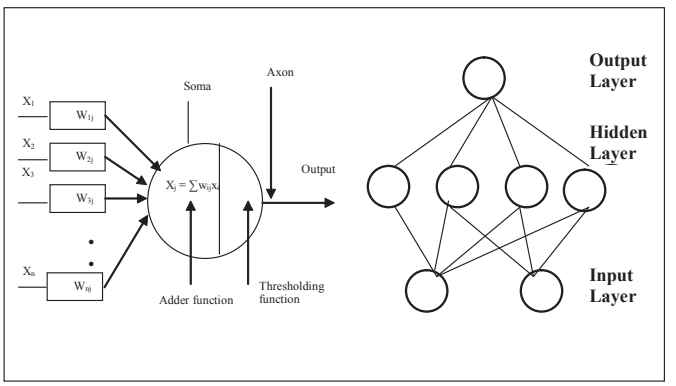
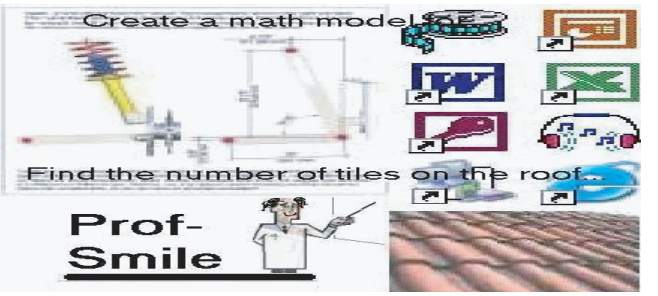



*Figure 4. The first screen of Professor SMILE when it is loaded and running*




configuration of the neural networks based on the supervised learning paradigm is shown in Figure 3(b).

There are two distinct operations, which take place during the training phase; the first one is the feed forward computation and update of the weights based upon the error of the network's output. Typically each neuron in the network uses the same activation function and threshold value. First, the connection weights between the hidden and output layers are adjusted along with the activation thresholds in the output nodes. In the second state, the connection weights between the input and the hidden layers are adjusted along with the activation thresholds in the hidden layer to reduce error in the output. This error is defined as

$$E_p = 0.5*\sum(t_{pj} - o_{pj})^2 \quad (1)$$

Where $E_p$ is a measure of error on input/output pattern p and $E = \sum E_p$ is the overall measure of error. Here $t_{pj}$ is the value of target output, and $o_{pj}$ is the output value of the network. With hidden units there is a possibility of getting stuck in local minima. The derivatives can be calculated by generalized δ rule. The generalized δ rule works for layered feed forward networks with any number of hidden layers between the input and output layers. The following equation is used in the learning algorithm to calculate the change in weight (ξ) whenever the node (neuron) is an output node. Here, $w_{kj}$ are the weights between the layers.

$$\xi_{pj} = o_{pj}(1 - o_{pj})\Sigma k \xi_{pk} w_{kj} \quad (2)$$

The application of the generalized delta rule involves two phases. During the first phase, called the forward phase, the input is presented to and propagated forward through the network to compute the output value $o_{pj}$ for each output unit. For each processing element, all current outputs are compared with the desired output, and the difference, or error, is computed. The second phase, called the backward phase, involves a backward pass through the network during which the error signal is passed to each unit in the network and the appropriate weight changes are made. Only when these two phases are completed, can the new inputs be presented. Neural networks based on both paradigms were simulated and evaluated for prediction and performance. Our research also concludes that neural networks based on the supervised learning paradigm require a lot of training time, are unstable, very sensitive to tuning parameters, and generally get stuck in local minimas. On the other hand the neural networks based on the unsupervised learning paradigm are significantly faster and are less sensitive to tuning param-

*Table 3. Typical examples of the tasks provided by Professor SMILE*

| |
|---|
| ***Example 1:*** |
| What is the number of rectangular roof tiles, to cover the roof area shown in the picture? Assume each rectangular tile is 30cm by 15cm |
| Case 1 assumes tiles just touch. |
| Case 2 assume tiles overlap 1cm all the way round its perimeter. |
| ***Example 2:*** |
| Create a simple math model of the car suspension for a simple two spring two mass damper system. |
| ***Example 3:*** |
| You work for a telephone company. Your boss has asked you to answer some questions about smart phones. He also wants some information on customers. Do the following Tasks. |
| a) Your company sells 6 different Smart-Phones. The sales for 2004 are in the Smart-Phones Sales 2004.doc file. Your company wants you to calculate the profit for each model. |
| a1. Choose the best software to use. |
| a2. Make sure the information about the Smart-Phones is clear and easy to read. |
| a3. Calculate the profit that each model is making. |
| Profit = (Price - Cost)*Number Sold |
| a4. Save your document as Smart????? Where ????? are the last 5 digits of your id number? |
| b) The company has decided to sell only 5 different Smart-Phones in the future. Which phone do you think they should STOP selling? Give your reasons. |
| ***Example 4:*** |
| You are the manager of a new perfume shop, which is about to open. Create a flyer for your shop and also make it into a web page. |

*Figure 5. (a) User is prompted for the choices of different varieties. (b) User can choose different learning modes. (c) User can become administrator or learn DBA activities. (d) User has a choice of different subjects to study. (e) The choice can be of different areas, learning and testing modes, etc. (f) The systems generated "Brain Map" for number of tiles on roof problem. (g) Professor SMILE provides a possible answer for roof tiles problem. (h) Computer generated "Brain Map" for Smart Phones Scenario*

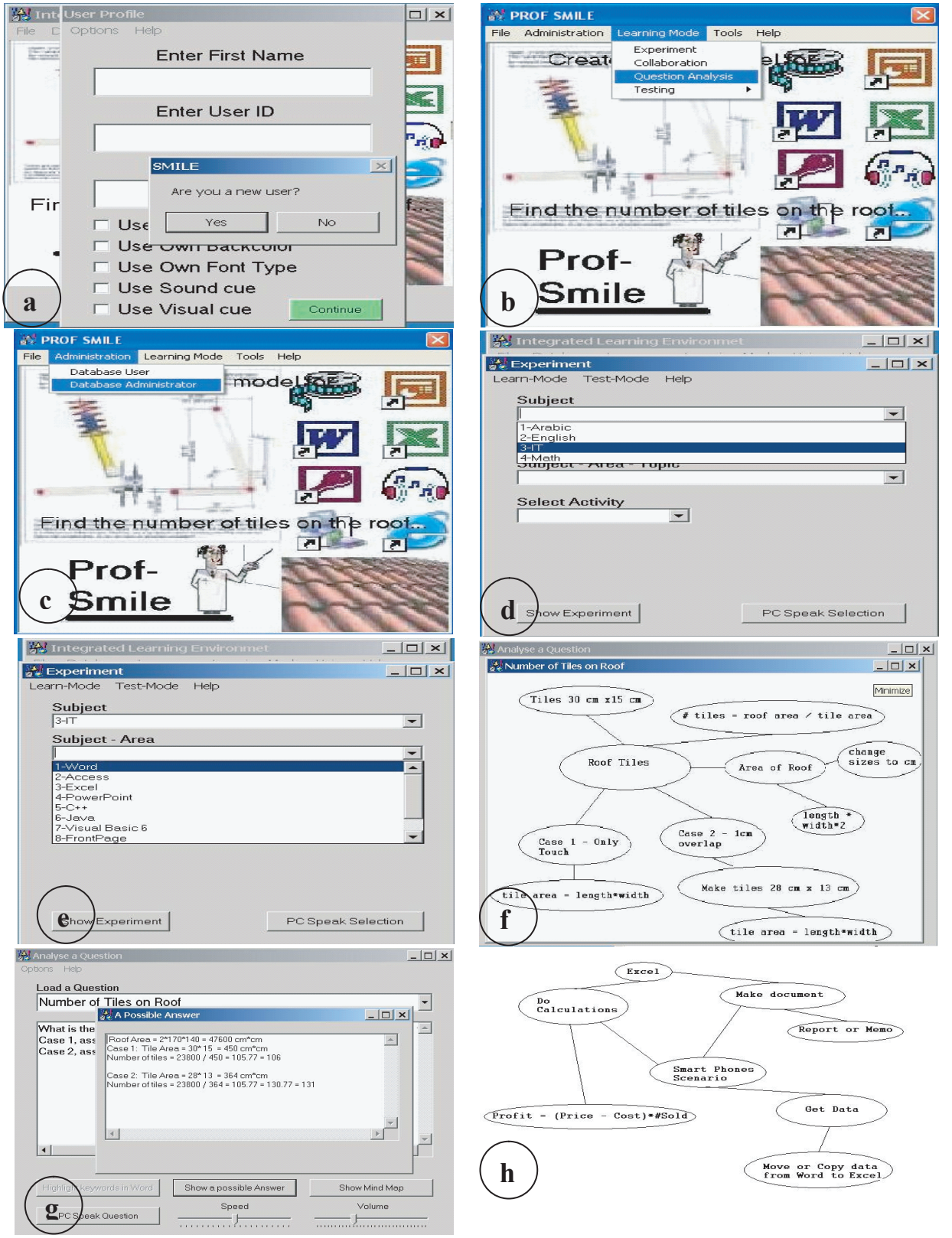
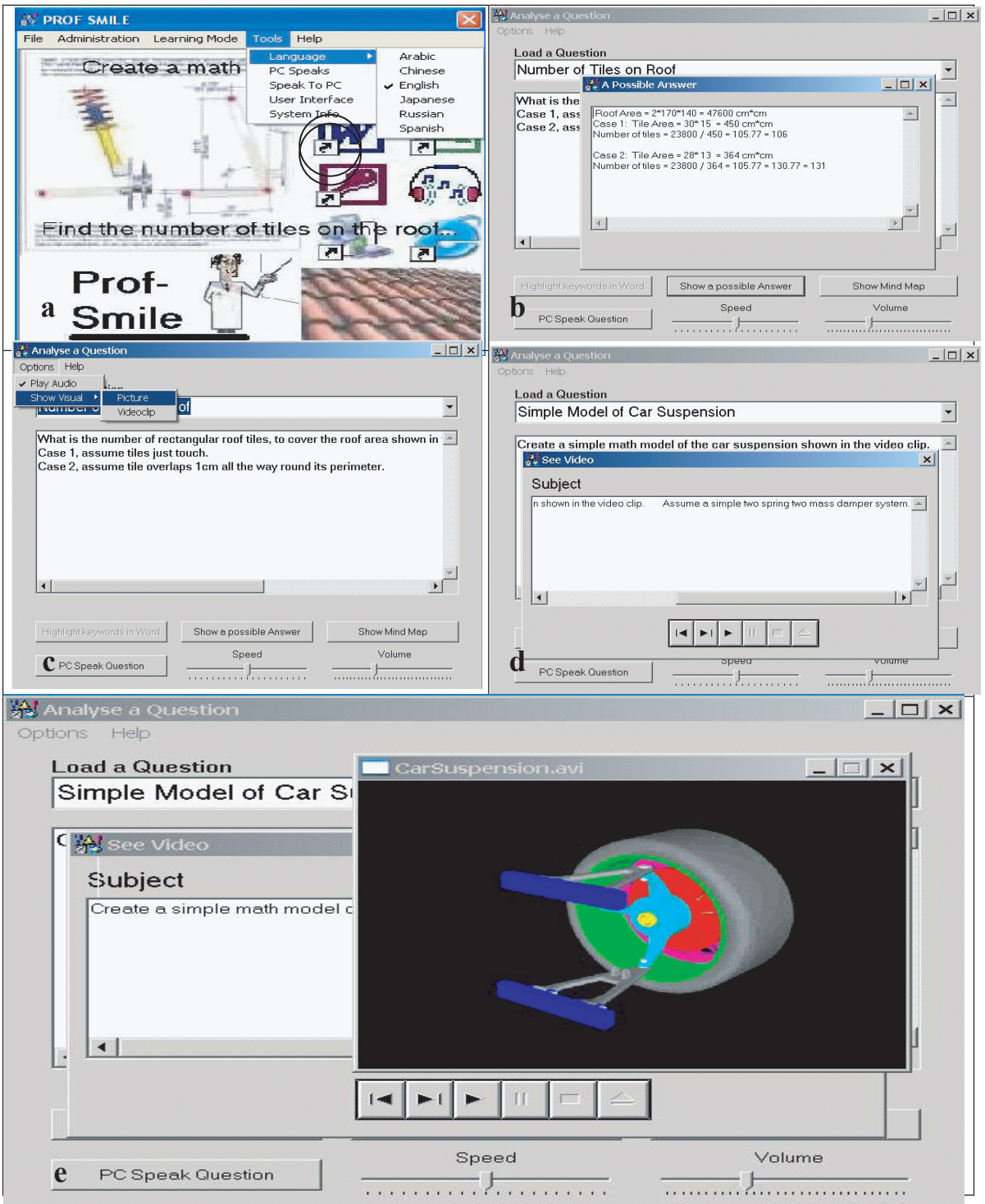


*Figure 6. (a) Physically disabled person has a choice of different facilities and options. (b) Calculation of the tiles for a disabled person. (c) Let us analyze the roof tiles problem. (d) Solution of Car Suspension problem. (e) A better method of solving a problem for a disabled person*




eters. The neural networks based on both paradigms simultaneously along with feature enhancement on every step provide a much faster, robust solution which is less sensitive to tuning parameters. Neural networks could be easily used for prediction of learning outcomes of any cluster of university students based upon their past performance. The developed and tested neural computing module will also be incorporated with Professor SMILE.

## 4. TEACHINGS OF PROFESSOR SMILE

### 4.1 Why Learn from Professor SMILE?

Some of the compelling reasons are as follows: (i) It understands the learning requirements of students. (ii) It is available all the time. (iii) It is intelligent. (iv) It does not show negative human emotions. (v) It does not follow any religion. (vi) Cheaper and less dangerous to simulate than build, buy or operate a real system. (vii) Its software tools provide a highly visual 2D or 3D animated model of your "system". (viii) It provides a tool to play very realistic "what-if" games. (ix) User can see animated flow of various data objects. (x) Various Model Parameters can be modified e.g.: Realistic processing time delays can be used in various objects.

### 4.2 Learn To Design and Solve Complex Problems with Professor SMILE

Professor SMILE finds it easy to teach the following difficult IT topics using a simple DES (Discrete Event Simulation) model and enhance students' visualization: (i) The Program Development Life Cycle (PDLC); and (ii) the Steps of the General Algorithm.

### 4.3 Learning Process For Normal Person

The normal person can start learning from Professor SMILE by keying the basic personal information which helps the system to build a user profile. The student profile is used by most of the system modules. Some of the Professor SMILE's interactive screens are shown in figures 4 -6. Some typical examples of the tasks provided by Professor SMILE are shown in Table 3.

### 4.3 Learning For Physically or Mentally Disabled Person

The system has also been designed keeping in mind the problems faced by physically or mentally disabled persons. They can choose to speak, listen or feel the system. If any touch-coded sign language is available, it can also be incorporated into the system. The physically challenged person has an obvious choice of speaking out his information through microphone. He/She can hear computer-generated output through a speaker or headphones.

## CONCLUSION

Our research clearly shows that there is a wide gap between present and future Information Technology (IT), taught in higher education, and real use of IT. It also shows that different students have different styles and strategies for studying IT.

Certain changes were made in the IT curriculum with respect to educational goals, content, teaching methods, and methods of assessment. Regarding teaching methods, lecturers now share the class time with the students, thus engaging them in their learning experience. Generally speaking, the new curriculum has successfully changed from a textbook, lecturer-centered model to a learner-centered model, providing more active student participation in the educational process.

Still it is not enough. The gap has been narrowed but not closed. For example, course content in the new ICT curriculum does not contain all the information needed for students to learn a subject, thereby requiring the students to do their own research to complement the information in their texts. Some areas still need improvement, but the current trend is one that will be consistent with guiding our students to become critical and creative thinkers, able to search out, understand, analyze, and synthesize the information they will need to become world citizens and world leaders.

We strongly believe that simulations can be an effective counter to many of the aforementioned issues. Professor SMILE is an innovative, intelligent, robust and ubiquitous computer system to teach ICT to students in higher education. Its implementation is object oriented and it also incorporates a DES shell which no other working academia project uses at this time. Its design also makes it available on internet, mobile systems and it is ideal for use by disabled people. It can be used to teach Mathematics, English, Arabic, Science, Engineering and IT courses. It is a versatile system, which can be upgraded to teach most things a human being can teach. This model has already been tested with some students to obtain data on what students find difficult to conceptualise and understand in IT. The project is currently continuing. Piloting in other institutions may be a possibility in the future. We are available to help others start similar projects in academia and industry; however, the nature and terms of help would be different for industry and academia. The new ICT is a gift of the UAE University to a new Arab world along with an innovative, intelligent, critical and creative thinker, Professor SMILE, to teach the future generation.

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## ENDNOTES

1 By the way, similar name Ismail is well known in the Arab world. He was one of the Prophets, (PBUH).

2 In the Holy Qu'ran there are approximately 6236 verses.