Smart Agent Based Mobile Tutoring and Querying System

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Abstract

With our busy schedules today and the rising cost of education there is a need to find a convenient and cost effective means of maximizing our educational/training experiences. New trends in the delivery/access of information are becoming more technology based in all areas of society with education being no exception. The ubiquitous use of mobile devices has led to a boom in m-commerce. Mobile devices provide many services in commercial environments such as mobile banking, mobile purchasing, mobile learning, etc. It is therefore fitting that we seek to use mobile devices as a platform in delivering our convenient and cost effective solution. The proposed agent based Mobile tutoring system seeks to provide a student with a rich learning experience that will provide them with the relevant reading material based on their stage of development which allows them to move at their own pace. The system will allow the user to be able to ask certain questions and get explanations as if they were interacting with a human tutor but with the added benefit of being able to do this anytime in any location via their mobile phone.

1. Introduction

Education plays a significant role in everyone's life at some point in time or another, though it may affect each of us in different ways and on different levels. Different persons learn at different rates and therefore it is difficult to tailor a course to be delivered to students that will allow them to grasp the material at the desired rate within a specific time. In this respect, a tutor teaching too fast may cause some students to be left behind and not to have a proper understanding of a subject area. On the other hand a tutor teaching at a slower rate may make some students to lose the interest in the subject which may ultimately hold back the student. For a tutor to be effective there needs to be some form of balance in the rate at which teaching is imparted. In addition to this aspect, the amount of material to students and also the assessment process to determine the individual's level before delivering more material should be taken into consideration. The method of delivery of the material is also important in this regard. Some students may need a personal tutor but this can be expensive in terms of cost and time for traveling, not to mention the cost of the tutor. It is therefore important to find a cost effective means of obtaining the required tutoring service at one's convenience. With the advent of Internet and Mobile Technology, there has been quite an amount of work done in the area of Electronic and Mobile Learning and also agent based approach in Mobile learning to seek solution in the current educational issues. Taking these aspects into consideration we here propose a Smart Agent based Mobile tutoring and Querying system, which is far more superior to the earlier agent based Mobile tutoring system [1] published and it also gives an important feature for students towards asking questions by means of the agent based system and getting explanations and answers. These are explained in detail in the process flow and implementation section by means of screenshots. The rest of the paper is organized as follows. Section 2 talks on Electronic Learning. Section 3 talks on earlier work done in the area of Intelligent Agent based Mobile Tutor. Section 4 talks on the proposed Smart Agent based Mobile Tutor and Query. Section 5 talks on implementation of the system using JADE-LEAP tool. Section 6 is the concluding section with future work envisaged.

2. Electronic Learning

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Before going into the details of the Technology driven learning i.e. E and M- learning, we may mention here that the most primitive way of delivering education over distance that has been in vogue was by using postal service. Distance Education is the process of using technology to deliver educational instructions to students over a distance [2]. There are benefits in the form of increased enrollment due to the flexibility of not having to relocate the access to education. Potential students who are located at great distance from the institutions can still get enrolled and acquire the necessary qualifications. Also, potential students who are unable to enroll in an institution as full time student due to financial constraints, can still do so through distance education and while being gainfully employed [3][4]. Capacity constraints at the institutions can also be however, alleviated by offering some courses as distance education courses. There are however some disadvantages and these include that of the student not being able to fully take advantage of the complete school experience or facilities. Not everyone can adequately learn outside a classroom environment. In the past, distance education as mentioned, previously relied mostly on the postal service to facilitate the transfer of educational material. This has however been replaced by appropriate electronic means which has given birth to the concept of E-Learning [5]. This enables the facilitation of more students as the modern student would have already been exposed to the technology and would be familiar to embrace computerized education. Electronic learning (E-learning) is simply learning through using these electronic means. This is a very powerful concept as it enables persons who may not be able to formally attend classes or persons who lack physical and/or financial resources to access educational material for personal growth or professional development [5][6].

It may be mentioned here that these days, the Internet is by far the most popular means for information exchange. Its use has become so popular now that most persons want to have access to the Internet wherever they go. This aspect has now given rise to the use of mobile devices that are capable of connecting to the Internet [7][8]. It is therefore inevitable that there would ultimately be a natural progression towards using mobile devices for learning also. This aspect is known as M-learning and M-learning allows students to gain access to educational material at anytime and in any place. Mobile devices such as cellular phones have the advantage of not only being able to deliver material via the Internet but also via the public telephone network, generally in the form of text messages. With the proliferation of cellular phones and other smart mobile devices, it is easy to see why they have constantly been chosen to be used as a platform for delivering low cost one-to-one tutoring solutions to a wide audience of students [9-10]. Taking these into consideration we will now look into some of the existing Agent based Tutoring Applications so developed for the purpose.

3. Intelligent agent based Mobile Tutor

Before looking into the Intelligent Agent based mobile tutoring applications available, we will revisit Intelligent Agents in brief. Intelligent agents are autonomous entities which observe and act upon an environment and direct its activity towards achieving the desired goals [11-13]. Agents may be human or artificial. In our case, a human agent could be a school teacher, teaching students to do say, mathematics, an engineer designing and building bridges, etc. An artificial agent could be a robot performing complex tasks, managing a software system that diagnoses and solves problems, etc. The need for artificial intelligent agents arose towards accomplishing specific activity like problem solving or reasoning tasks in a repeatable and in an efficient manner [11]. Humans have the tendency to get tired and/or make mistakes as the time passes. Artificial intelligent agents on the other hand are capable of replicating some human cognitive abilities in performing tasks, with the added benefits that they are prone to fewer mistakes and they never get tired with time. Now with this in mind we will look into some of the Agent based tutoring applications presently available. With the intelligence and flexibility that agents posses, it is no surprise that developers have used agent based technology to deliver tutoring services. Intelligent agent based mobile tutoring systems such as those developed [14 -20] have had great success and has contributed to the inspiration of using agent technology to aid in finding a solution to the respective research problems. Most of these systems have been developed for being used with larger mobile devices such as laptops and tablets/pads, mainly due to the limitations that existed till recently with mobile phones. Some of these limitations include, small screen sizes, limited processing power, limited bandwidth, etc [14-20]. With the increasing popularity and capabilities of mobile phones and the availability of high bandwidth infrastructure such as GPRS, 3G and UMTS networks, intelligent tutoring systems are now capable of being developed for use on mobile phones also. In this context it may be mentioned that the current technology such as LEAP [21], a lightweight and extensible agent platform, makes it possible for agents to run seamlessly on PCs, wireless devices and mobile phones [14] .Based on our survey on the research work so far carried out on mobile agent based tutoring systems, we are particularly interested in the work of Henry and Suresh [1] as it has some key concepts that will be used in this proposed implementation as a solution to the problem. There were however, some pitfalls noticed in the implementation carried out by Henry and Suresh [1] and a part of our motivation were to address those pitfalls also in our present solution. These pitfalls include:

•   A tedious pre-testing process which could be made more efficient. Here, regardless of the student's chosen perceived level of competency, the student is always asked 10 questions from the basic level and then 10 questions from the intermediate level. Depending on

their performance, they may also be asked 10 questions from the advanced level.

- Not accessible to a student via their mobile phone.
- In-ability to answer queries raised by students.
- Tests and exams only facilitate multiple choices type questions.

Our proposed system attempts to implement improvements suggested by users of the system developed previously [1]. These details are now discussed in the next section.

4. Smart Agent based Mobile Learning

Much research work has been done in the area of Smart Intelligent Agent based Mobile Learning [1]. They have outlined the basic concepts needed towards developing such a system. We will now discuss some of these basic concepts outlined by them [1] towards developing that System.

A purely human based tutoring system typically consists of three types of personnel, viz., the Lecturer, the Tutor and the Student. The system architecture as given in [1] consists of the following eight components.

1. Tutor GUI: This is the facility through which the student interacts with the Tutor Agent. It provides authentication of student credentials and it is the interface with which the student does all the learning activities.
2. Administer Test component: This component is responsible for all the tests that the student will take throughout the course. These range from Pre-tests which are usually done at first log-in, module tests, unit tests and final exams.
3. Tutor Agent: This is the agent that simulates the intelligence of a human tutor. The student does all interactions through this agent via the Tutor GUI.
4. Question Bank: This is a storage area for questions that make up various tests, which the Teacher Agent retrieves and passes on to the Tutor Agent to be administered to the student.
5. Teacher Agent: This is the agent that simulates the intelligence of the human lecturer. It does all the direct interactions with the schools database. It then communicates the results of the database interactions to the student via the Tutor Agent.
6. Course Material Distribution: This component supplies the student with course material based on their achieved competency level as the course progresses.
7. Create Question Bank: This is the facility through which a human lecturer can create questions within the question bank.
8. Learner Registration: This is the facility in which the human course administrator can add/edit student's access to a course along with their credentials.

The first three components are on the student's mobile device i.e. Laptop/Net book/Tablet PC and the remaining five are on the school's server. Our system now proposed in this paper is an extension of the Intelligent Agent based Mobile learning system developed by Henry and Suresh [1] just described. There are however, some key difference between our present system and the system developed by Henry and Suresh [1] and these are outlined as follows:

- A key difference in Henry and Suresh's system and this proposed system is that a student will first be assessed based on their suggested level. In the implementation by Henry and Suresh [1], if a student claims to be at intermediate level then also the system starts asking questions from the basic section and progresses towards the advanced level. In this paper we let the student to suggest his/her level of knowledge, and then start the assessment from the suggested level with an increasing level of difficulty. After the assessment is complete, the student is then presented with the relevant material based only on the outcome of the assessment.
- The second difference is making the system accessible to a student via his/her mobile phone whereas in the previous system, it was accessible from Laptops, Netbooks and Tablet PC only, due to the limitation of J2ME handset in terms of Screen size, power and so on.
- The third difference is that our present system being proposed provides a facility for answering queries raised by students. It also provides an explanation/answering facility that gives the student the correct answer and an explanation for the correct answer.
- The fourth difference is that our present system allows inputting short answers for some questions in an assessment, rather than in the nature of multiple choices.
- The final difference is that our present system restricts students from taking the final examination via their mobile device more than once.

Our present implementation includes all the eight components outlined in [1]. The only architectural difference between both systems is that our present implementation is geared towards mobile phones. Therefore, our Tutor Agent resides on the student's mobile phone as opposed to the provision in [1], in which the Tutor Agent resides for example on the student's laptop. An Android smart phone will be used as the mobile device in the Smart Agent based Mobile Tutoring and Querying System [22]. It is the means by which the student interacts with the system (i.e. it provides the entire GUI). It hosts the Tutor Agent which in turn interacts with the other components of the system. A network

environment is however, necessary for both types of agents to communicate. This network can either be a private network such as a Local Area Network (LAN) or a public network such as the Internet

Fig.1 shows the physical architecture of the system now being proposed. For successful communication, it is important that the mobile phone is either connected to the network via a WiFi (Wireless Fidelity) connection or to the Internet (possibly through a 3G connection). If the mobile phone is not connected to the network, then the system supports asynchronous communications that will allow delayed transmission of information as soon as the device has re-connected to the network.

We will now provide the modified basic concepts of the mobile learning process as outlined by Henry and Suresh in [1] towards designing our algorithm. This we shall call as our process flow and this is shown in Fig.2. Our process flow consists of the following 5 steps, namely:

1. Login: The student starts the application, logs in and is directed to the relevant subject area.

2. Pre-Test: If the student has not completed the competency test then he or she is prompted to provide his or her perception of his or her competency level, otherwise he or she moves to step 3. Competence levels are as follows: Basic, Intermediate and Advanced. The Tutor Agent requests a pre-test from the Teacher Agent. This is based on the student's perceived level.

a. A maximum of 10 questions will be asked for a given competence level. Each question asked in increasingly level of difficulty.

b. If the student gets the first five questions right then the following conditions apply: If the student gets 3 out of the remaining 5 questions right and there is a higher level, then set the level higher and start testing at the higher level. Otherwise go to step 3. If the student does not get 3 out of the remaining 5 questions right then go to step 3.

c. If the student does not get the first five questions right then the following conditions apply: If the current level is the lowest level then go to step 3. Introductory material will also be provided. If the current level is not the lowest level and the student has not yet been tested at the level below the current level, then set the level to lower and start testing at the new level. If the current level is not the lowest level and the student has been tested at the level below the current level then go to step 3.

3. Provide Course Material: Based on the student's competency level attained, the Tutor Agent will request the relevant material from the Teacher Agent and provide it to the student. Each topic within a given course is associated with a competency level. A student starts with the topic that is the easiest within the associated

competency level and progresses towards the most advanced topic within the competency level. Progress can only be made by way of passing an end of topic test after reviewing the material.

4. Review and Query: The student will review the material and can ask the Tutor Agent questions about the material. The Tutor Agent provides the student with answers to the queries (questions).

5. Test and Query: Upon completion of reviewing the material, the Tutor Agent requests the relevant test from the Teacher Agent and administers it to the student. A pass is denoted by getting at least 50% of the questions right.

a. If the student passes then the following conditions apply: If there is a higher level then he or she is placed in the higher competency level and goes back to step 3. If there is no higher level then the student passes the course.

b. If the student fails then the following conditions apply: If the test is a final exam then he or she will have to re-take the course. If the test is not a final exam then the student, via the Tutor Agent can query the answers to the questions that he or she got wrong and gets the correct answer along with explanations. The student would then be required to go back to step 4.
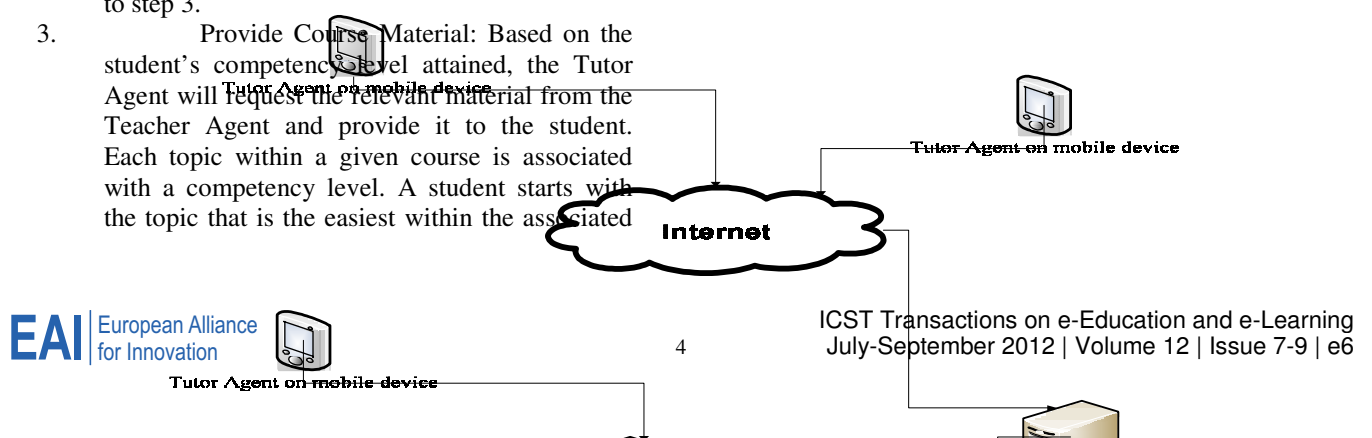
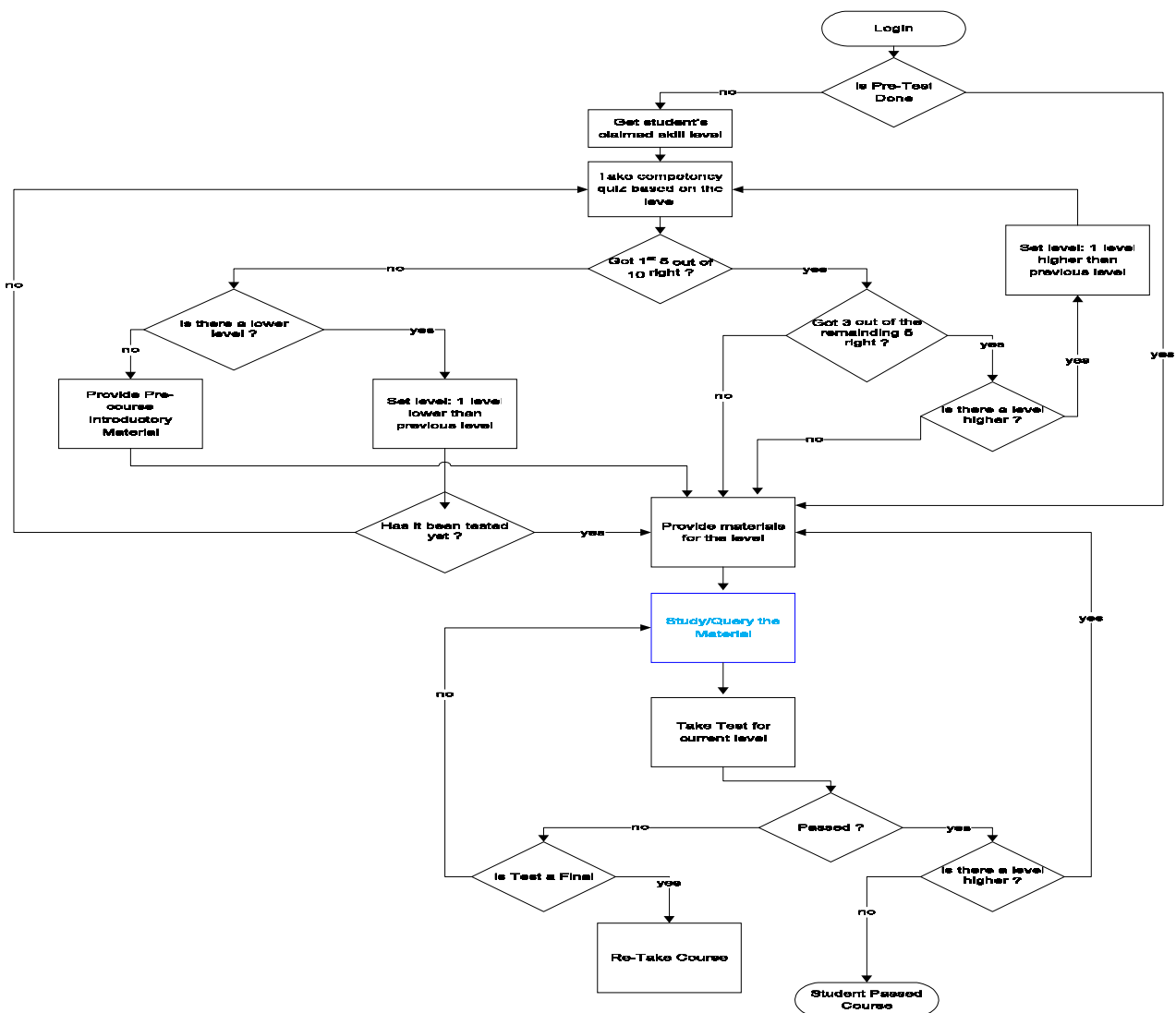**Figure 1.** Smart Agent based Mobile Tutor Architecture

Figure 2. Smart agent based Tutor Process Flow

5. Implementation Using JADE LEAP

Our proposed Smart Agent Based Mobile Tutoring & Querying System was implemented in Android 2.2 [23] using JADE and the JADE-LEAP add-on tools. JADE (Java Agent Development Environment) [21] is a full agent middleware platform. The JADE platform is composed of agents and containers that they "live" in. The agent platform contains two default agents, Agent Management System (AMS) and Directory facilitator (DF). The prior is responsible for the management of agents and the latter used to discover and manage the services that an agent offers through its yellow page functionality. The agent containers can be distributed over the network. A special main container coordinates and acts as the bootstrap for the JADE platform and all other containers must register with this main container.

In our implementation, there is a main container on a server computer at the school that houses the Teacher Agent and several split containers representing each student's mobile phone that houses Tutor Agents on each student's phone. Communication between agents is done via ACL (agent communication language) message passing [23]. Fig.3 shows two Tutor Agents and one Teacher Agent along with the AMS, DF and RMA agents in JADE.

5.1 Login

With reference to Fig.2, the flowchart, depicting the concept proposed, to gain entry in to the system (also referred to as the mobile tutor or the Tutor Agent), a student must provide credentials to be authenticated against a user database. The Tutor Agent passes these credentials to the Teacher Agent who performs the authentication function. If authenticated, then the Teacher Agent first checks to see the number of courses for which the student has done enrollment and then provides a menu to allow the student to proceed to the desired course based on the student's enrollment status. For simplicity in our example, we have the student enrolled in only one course viz, the Java programming course, as shown in Fig.4.

Once logged in, the student is given the option to choose his competency level as felt by him, say as Basic, or Intermediate or Advanced. If however, the student has already completed the competency test for the given course, then the student is given the relevant material to pursue the course, based on the competency level already reached by him. If the student has not completed the competency test yet, for the given course, then he/she is prompted for his/her perception of the competency level. This is shown in Fig.5. Now once logged in and the competency level selected, Pretest begins for that level of competency. How this is done is shown in the forthcoming section.

5.2 Pre-Test

Once the student selects the perceived competency level, then the pre-test begins as shown in Fig.6. A maximum of 10 questions are asked at the given level. Questions are asked in the increasing levels of difficulty as the test proceeds. This means that within a given level, the earlier questions are easier than the later questions.

At the basic level the student is given 10 minutes to answer the questions. At all levels, a timer counts down to show to the student how much time is left out for answering. If the student does not get the first five questions right then the student will be placed in the basic competency level and provided with introductory material as well as material from the first (simplest) topic within the basic competency level category as shown in Figs.6 and 7. The student would not be required to take a test on the introductory material. However, the student will be required to take an end of topic test on the basic material upon completion of the reviewing the material.

If the student gets the first five questions right but does not get 3 out of the remaining 5 questions right, then they are also given material but at the basic level. Now if the student gets the first five questions right and gets 3 out of the remaining 5 questions also right then the student will be tested at the intermediate level as shown in Fig.8. At the intermediate level the student is given 20 minutes to answer the questions. Now if the student does not get the first five questions right at intermediate level the student is given material at basic level as shown in Figs.9 and 10. If the student originally selected intermediate level or advanced level but failed, i.e, does not get the first 5 questions right at the intermediate level then he/she is tested at the basic level only as shown in Figs.6 & 7. If the student gets the first five questions right at intermediate level but does not get 3 out of the remaining 5 questions right then the student is given material at the intermediate level as shown in Fig.10. Again, the student is presented with the simplest topic within this level and is required to do an end of topic test in order to progress to the next topic.

On the other hand if the student gets the first five questions right at intermediate level and gets 3 out of the remaining 5 questions right then the student is then tested at the advanced level as shown in Figs. 11 and 12. Similarly if the student does not get the first 5 questions right at the advanced level then he/she is given material at the intermediate level.

At the advanced level the student is given 30 minutes to answer the questions as shown in Fig. 13 . If the student originally selected advanced level and does not get the first 5 questions right at advanced level as shown in Fig. 14 then they are tested at the intermediate level as shown in Fig.9. If the student gets the first five questions right at advanced level as shown in Figs 15 and 16 then the student is given material at that level starting. Fig.17 shows the student who claims their level as advanced but Tutor agent finds that the student level is basic only.

5.3 Course Material

Based on the topic answered by a student within a given competency level, the Tutor Agent will request the relevant material from the Teacher Agent and provide it to the student. Upon completing a pretest a student will start at the most basic topic within the associated competency level.

Fig .18 shows topics that are both available and unavailable. A student will be able to view and query any topic within the available material. Regardless of a student's competency level, he/she can always view material at a lower level. The student will be required to take an end of topic test upon completion of the review of the material. He/she will only be able to take the end of topic test for the most current topic only and not for previous topics. The current topic is the one at the top of the available material list as shown in Fig.19. The student will be shown via the unavailable material list the topics that are left to be covered but they will not be able to view the details, or query or be tested on those topics until they have reached to those topics. The next topic to be reviewed is the one at the bottom of unavailable material list as shown in Fig.20. The Final topic is the one at the top of unavailable material list.

5.4 Review and Query

Upon viewing a topic within the available course material list, the student has the ability to query the material. Fig. 21 illustrates the view material screen shown in full screen mode, while Fig 22 shows it in the minimized mode. A question has to be structured as follows in order for it to conform to the format expected by the mobile tutor:

1. A question must contain one or two key terms.
2. A key term consists of a minimum of one word and a maximum of three words.
3. A key term must be enclosed in square brackets. Example: [key term].

The following algorithm shows how our mobile tutor is able to answer queries:

- *The mobile Tutor Agent takes the input and strips away everything that is not a key term.*
- *It searches all the available material up to the topic that the student has reached for occurrences of the key terms. It starts from the most basic material and moves towards the most advanced.*
- *During the search it locates every paragraph containing the key terms and returns an excerpt from the paragraph. The excerpt starts from the first sentence within the paragraph that contains the key terms and continues to the end of the paragraph.*
- *If there is more than one key term then repeat the process for the other key terms.*

The algorithm above is modeled in pseudo code as follows:

Sort the topics from most basic to most advanced
Start at the most basic topic
For each topic
*   For each paragraph in the topic*
*   If the paragraph contains the key term then*
*   Return an excerpt from the paragraph*
*   End If*
*   End for*
End For

In the above we see that the mobile tutor takes advantage of the syntactic properties of the English language with little or no understanding of the semantic properties of the English language. The semantics of the English language is very complex and would require the mobile tutor to possess some advanced artificial intelligence with very sophisticated natural language processing capabilities [24][25]. At present this work is beyond the scope of this paper and as such we have kept this work as a follow up in our future work contemplated in the area. However, in this paper we propose a simple mechanism to zoom in on the key terms within a question in order to provide the student with a satisfactory answer.

Fig. 23 shows a question (query) being asked to the mobile tutor. Here we are trying to find out what a class is. We present the question to the mobile tutor in the form "*what [is a class]*". The answer to the question as given by the mobile tutor is shown in Figs 24 and 25. The mobile tutor also has the ability to answer questions that require comparisons. This is facilitated by the student inputting two key terms instead of one as shown in Fig. 26. Here the student wants a comparison between instance variables and class variables. The question posed to the mobile tutor has been written in the form "*what is the difference between [instance variables] and [class variables]*".The answer provided to the question is shown in Figs. 27 and 28.

At times, depending on the question asked, the mobile tutor may not be able to answer the question or may even return too much information. With human tutors, it becomes necessary to rephrase such questions in order to get the desired response. The same also holds good for the mobile tutor. For example: "*what is an [object]*" may return more information than the student would like to see, although the desired answer would be embedded within the response. Also, the question "*[define an array]*" may not return a result (i.e. the mobile tutor cannot answer the question). These two problems may be solved by rephrasing as follows:

- Change "**what is an [object]**" to "**An [object is]**"
- Change "**[define an array]**" to "**[An array is]**"

It could be noted from the above narration, that the mobile tutor can answer a question o n l y if the answer is contained within the available material. If the answer exists in the available material then it will provide one, otherwise it will display a message similar to the one shown in Fig 29. It is therefore reasonable to expect that the student would have some knowledge of the material available and would not therefore ask questions outside the scope (the subject area) of the material.

5.5 Test and Query

When a student has completed reviewing a given topic, the student must take the end of topic test in order to move to the next topic. Fig 30 shows a student who has reached the topic The Basic Java Application while Fig 31 shows that the next topic for review is Arrays. A student can take an end of topic test any number of times until he or she passes. During an end of topic test, questions are pulled randomly from the Teacher Agent within the given topic for the Test. The final exam however, can only be taken only once. The option to take the final exam is not available until the student takes and passes all the end of topic tests.

An end of topic test does not have a standard duration or a standard number of questions. These are parameters that can be set by the human lecturer. In addition, questions may be multiple choice type or short answer type questions. Fig 32 shows a short answer type question. Once the student has passed the test then he or she will be able to view the topic that is next in line (in this case: Arrays). At this point the student can still view all previous topics but can only take a test for the current topic.

At the end of topic test, a student is able to get a summary of his/her performance on the test. The summary shows:
• an indicator if the student has passed or failed
• the score that the student has received
• each question and the correct answer
• the student's response to each question
• an indicator if the student got a given answer to a question right or wrong
• an explanation for the correct answer

These are shown in Figs 33 and 34. The explanations for the correct answers were stored in the Teacher Agent's database at the time of creation of the questions and answers for a given test. The explanations aid the student in identifying where they might have gone wrong in answering a question.

When a student has successfully completed all the end of topic tests, he or she is required to take a final exam in order to complete the course. Fig 35 shows a student who has reached the stage of taking the final exam. Here we see that the student can take the final exam and is prevented from retaking an end of topic test. The unavailable material list is empty at this point because all material is available to the student. Final exams are similar to end of topic tests with the following exceptions:

• a final exam can be taken only once
• explanations of answers are not given for final exams
• the test summary only shows the student's score.

Fig 36 shows the state of the option that whether or not the student passed or failed, he or she is unable to retake the final exam.

6. Conclusion & Future Work

Learning applications, normally we employ a human agent i.e. Tutor and Lecturer to disseminate the information to the students. The e-learning environment, came into existence because the availability of the human being has become an issue as mentioned in the paper. In recent times, intelligent agents have gained considerable attention in the area of computer science. So based on that Agent based Mobile learning system [1] was developed for Netbook/Tablet PC which allows tutor agent residing on Netbook/Tablet PC to possess adequate intelligence to assess the student level and interact with the Teacher Agent for getting the required material for progressing in methodical fashion in the course. Teacher Agent gets the required material based on what the tutor agent reports.

From the user acceptance trials of earlier system [1], it is seen that the university students and Education officials did like the software and have give lot of positive criticism towards improving the system to be available on smart phones. Also they have found the system quite interesting to get tutored online anywhere. But some pitfalls noticed in the earlier system as outlined in the paper motivated us to develop the Smart Agent based Mobile Tutoring and Querying system which is far more superior compared to the earlier system.

This present research has shown a possible use of agent based technology in implementing a mobile tutor that acts in many respects like a human tutor. It assesses a student's competence level at various stages of their course of study and disseminates the appropriate amount of material so as not to burden a student or hinder their progress. It allows a student to query the material rather than be left alone without assistance in understanding the material. To have such a system on a mobile device is convenient and is a welcome enhancement in a student's learning experience. The results of the efforts have been shown as screenshots in the paper. Future efforts would include building a prototype of the system and then the acceptance testing of this prototype system by way of collecting data from students and staff using this system, in terms of various functionalities provided by the system in a classroom and also in distant learning setup. It may be mentioned here that time is needed to build a prototype system for that purpose..

In addition we also propose extending the capabilities of the mobile tutor by incorporating advanced artificial intelligent natural language processing similar to that employed in IBM's Watson [26] in the tutor agent residing in mobile handset for interacting with the Teacher agent. This would improve the querying capability. This could also give rise to the possibility of a student being able to ask questions via voice commands rather than typing the question. This capability would significantly increase efficiency and user friendliness.

With the continuous advancement in mobile phone technology, future storage and processing capabilities may facilitate entire course material being stored and processed in multi-media formats such as video and slide show presentations on any mobile phone. This however, should not preclude the use of text based course material. Last but not the least agent based system from the mobile should be made Web enabled rather than being purely agent based system which would allow the system to work from any kind of mobile device.
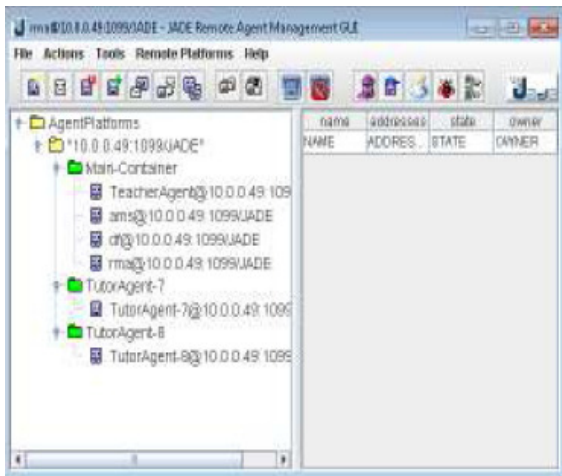
Fig.3 Remote Monitoring Agent GUI
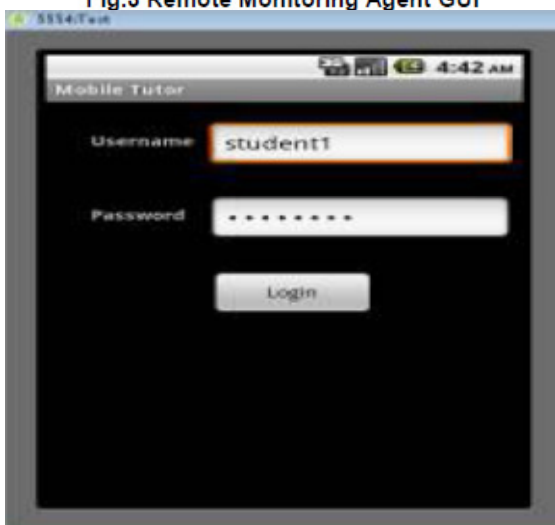
Fig.4 Login Credentials

Fig.5 Competency Level
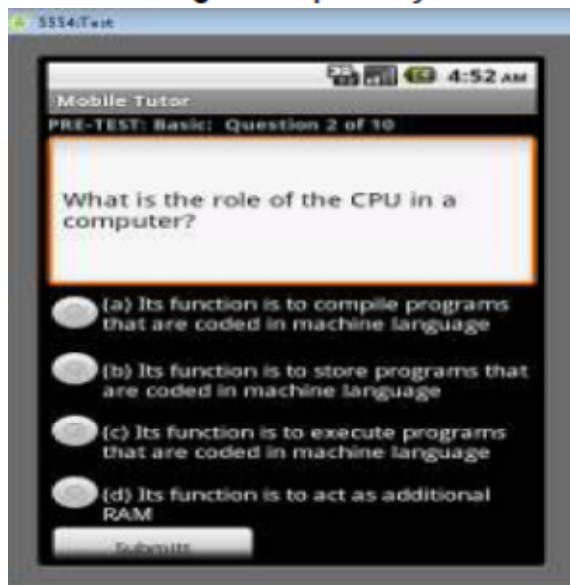
Fig. 6 Pre-Test Basic Level
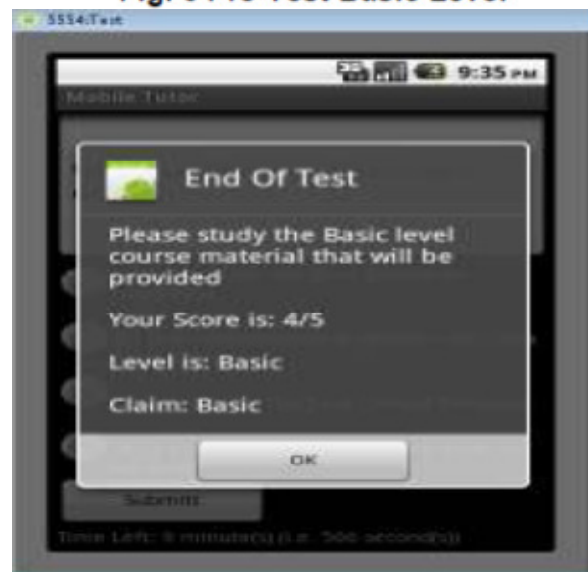
Fig.7 Basic level- Failed

Fig.8 Basic Level Passed

Fig. 11 Intermediate Level Achieved
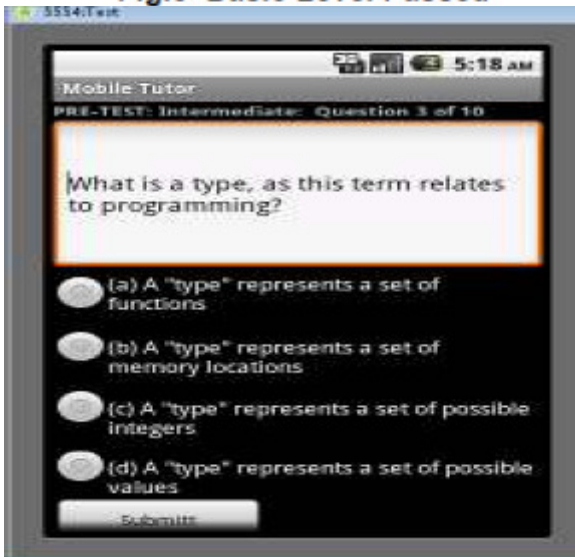
Fig.9 Testing at Intermediate Level

Fig. 12 Intermediate – Passed
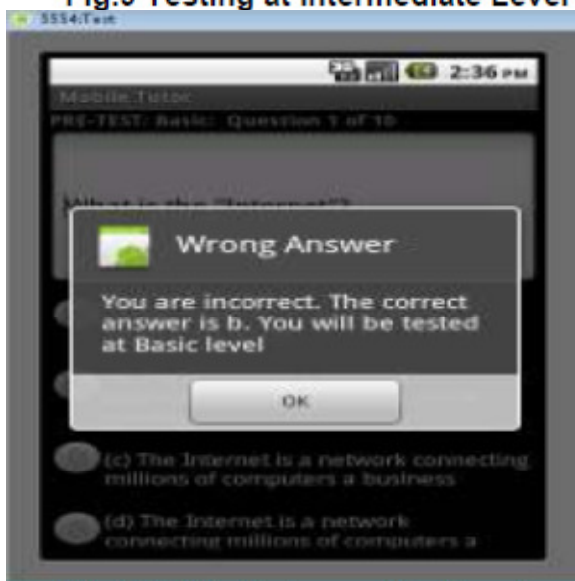
Fig.10 Failed Intermediate Level
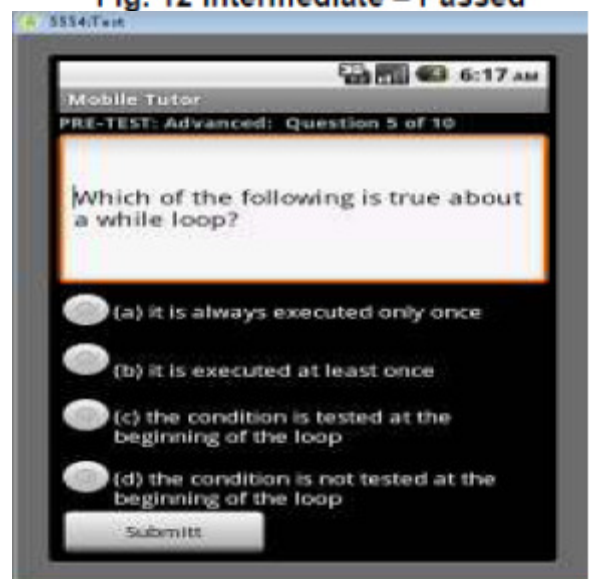
Fig. 13 Pre-Test Advanced Level

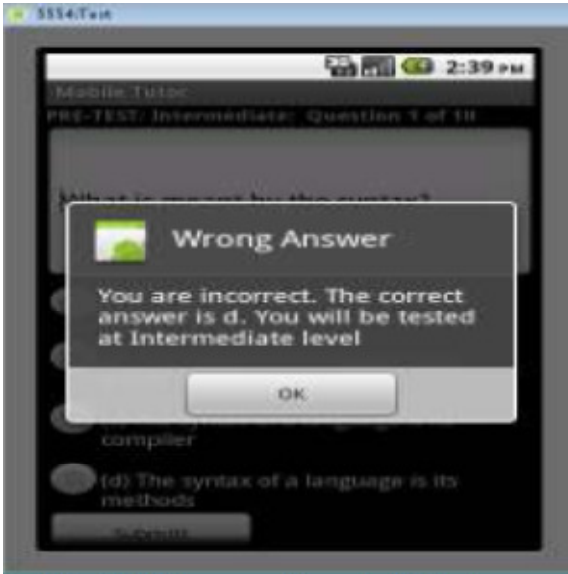Fig. 14 Advanced level- Failed

Fig. 15 Advanced level- Passed

Fig 16 Results – Higher level

Fig.17 Results – Lower level

Fig. 18 Course Material Lists

Fig.19 Available Topics

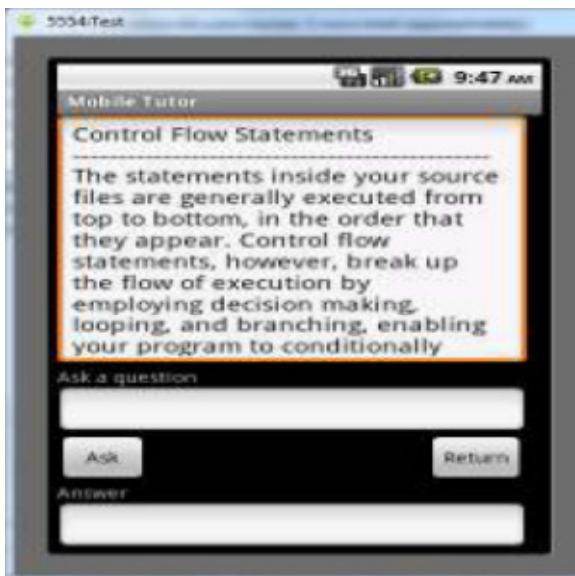Fig 20 Unavailable Topics
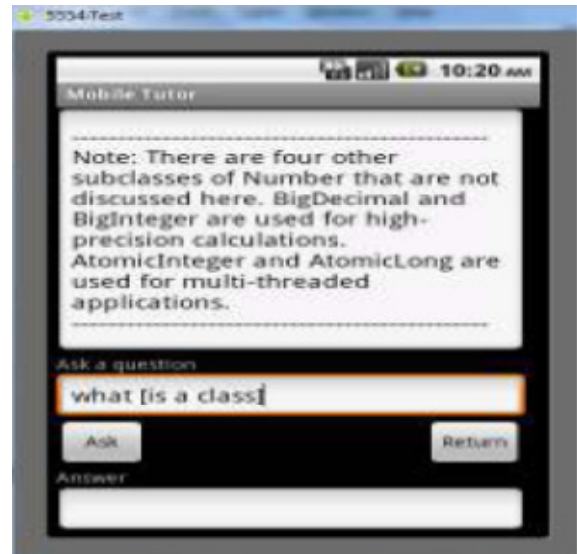
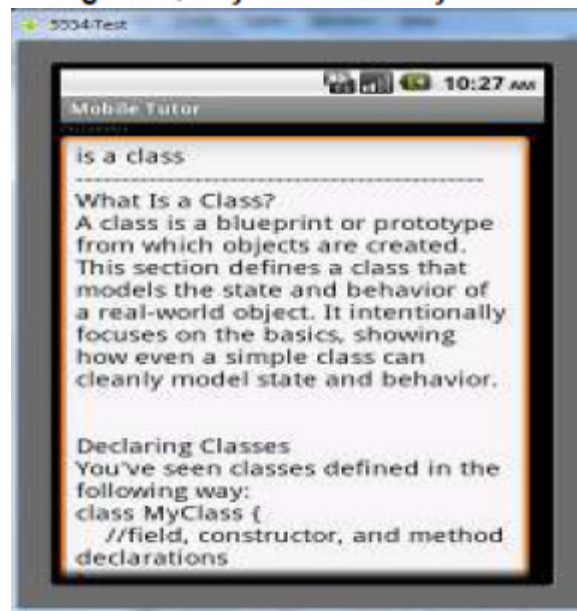Fig. 23 Query with One Key Term

Fig.21 View Material Screen – Minimized

Fig.24 Answer - part 1
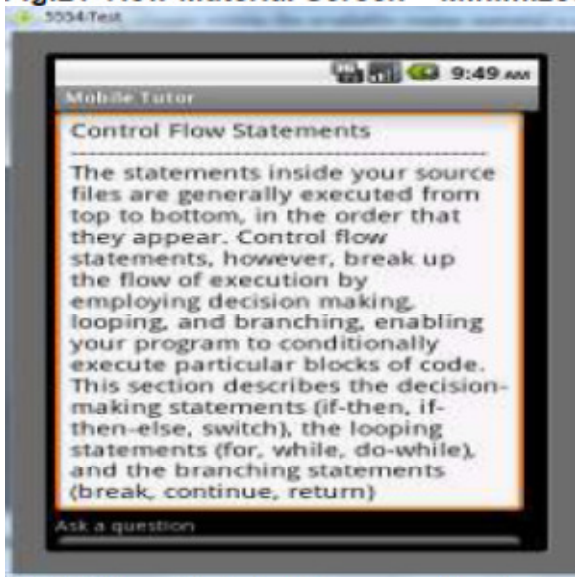
Fig.22 View Material Screen – Maximized
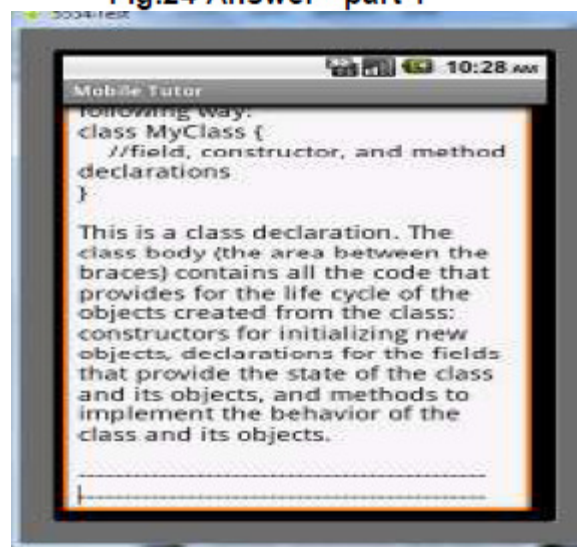
Fig 25 Answer - part 2
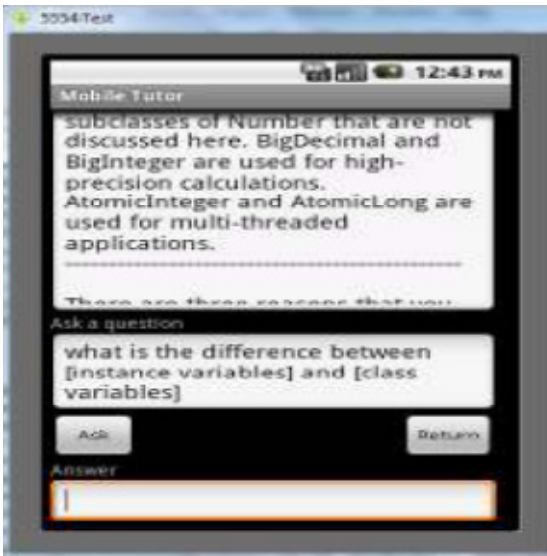
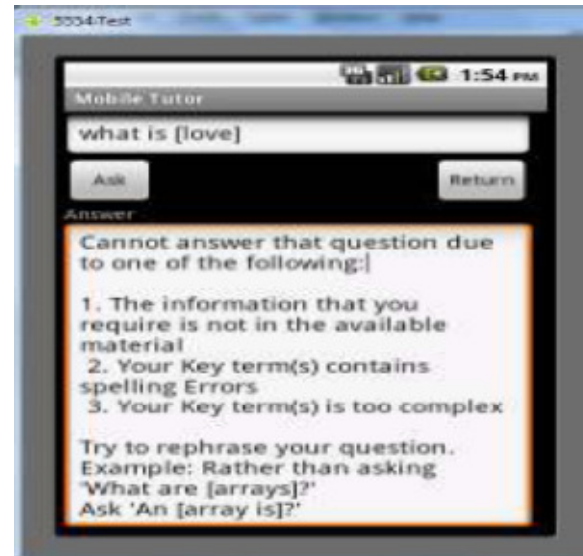Fig 26 Query with two key terms

Fig 29 Query Not Answerable

Fig 27 Answer -part 1

Fig 30 Current Topic for Review

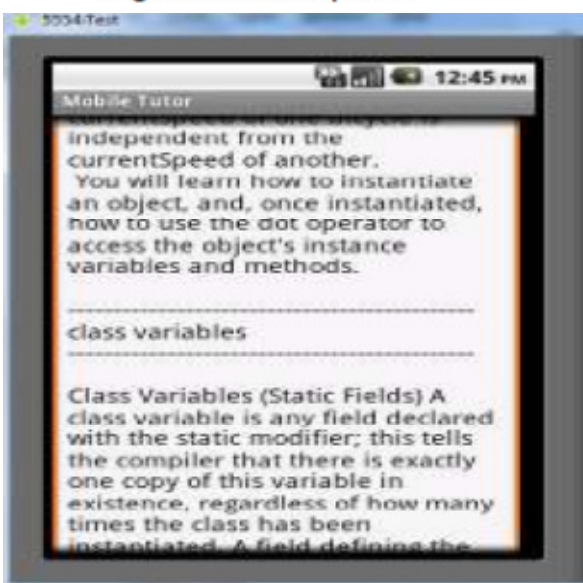Fig 28 Answer -part 2

Fig 31 Next Topic for Review

Fig 32 Short Answer Question

Fig 33 Performance Summary

Fig 34 Test Answer Explanation

Fig 35 Final Topic Completed

Fig 36 Final Exam- Unavailable

7. Acknowledgment

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