DESKTOP INTERACTIVE ACTIVITY DIAGRAM TUTORIAL

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Desktop Interactive Activity Diagram Tutorial

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The Supervisory Committee certifies that this disquisition complies with North Dakota State University's regulations and meets the accepted standards for the degree of

MASTER OF SCIENCE

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ABSTRACT

Activity diagram plays a vital role in Business Process Modeling as well as System modeling. In this paper, I have proposed a desktop interactive activity diagram tutorial that has been designed for educational purposes to help someone to construct activity diagram with the following features: (1) There is continuous interaction between the user and the system; (2) It provides ongoing feedback and performance updates to the user after every topic within the chapter; (3) the tutorial will generate a "Certificate of excellence" with the percentage scored if only the user has scored above 90 percentages and the certificate will be send to the user's given email address; (4) This interactive tutorial is extensible and acts like framework in the sense that, the database is designed in such a way that new tutorials can be added to the existing application without any modification to the front end.

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It would not have been possible to complete this research project without the assistance and inputs of all of the research participants.

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CHAPTER 1. INTRODUCTION

1.1. Background

Activity Diagram which is one of the important modeling diagrams in the Unified Modeling Language (UML) plays a vital role in Business Process Modeling as well as System modeling and is used for describing the dynamic aspects of any system. In the context of the Software Development process or system modeling, the importance of Activity Diagrams can be comprehended using the analogy of a building construction process. Just as the Architectural designs help in the effective communication between the builders and the architects, Activity diagram gives the blueprint of any process and thus helps in the effective communication between the end users, business analysts, system analysts, programmers, and everyone involved in creating and deploying the software systems in an enterprise.

It necessitates one in software development to learn about Activity diagrams because they are very useful throughout the software design process as processes occur at all levels of abstraction from requirements engineering to software design. It would trigger anyone involved in Business processes and system processes to learn about Activity diagrams because:

- It does not require any technical system analysis or design experience to understand Activity diagrams and hence it can be used as a graphical language to communicate with end users.
- Activity diagrams help business users to better understand the processes involved.
- Unlike flow chart diagrams, activity diagrams allow modeling of parallel processes through the use of synchronization bars.

- Activity diagrams can be used in modeling the detailed logic of single use case and complex use case flows as use case models don't communicate the order of the processes.
- Activity diagrams can be used instead of flow-charts for describing the complicated sequential algorithm.

New innovations are taking place in the realm of online content delivery. Our hunt for support resources begins the very moment we start learning a subject. In the pre-net days, our options were limited to consulting a few experts in the neighborhood and accessing text materials available in the local library. For a student of this age, such restrictions do not apply. Now, one has multiple means to facilitate their learning endeavor (free text materials - textbooks, handouts, a plethora of audio/video tutorials and several free online courses to cap it all). Though we witness a variety of learning resources, only a miniscule portion of it is used. This means, the value of each of the new units is declining and that too with an alarming speed.

There are a number of materials, documents (in word and PDF format) and tutorials that are available in the internet to learn about Activity Diagrams. It is very easy for someone to get bored reading those tutorials as it would become monotonous going from page after page without any interaction between the user and the tutorial.

The problem with the existing Activity diagram tutorials is that:

- There are a very few interactive tutorials but with broken links.
- Not all the information and notations of Activity diagram is available at one place. In order to learn about all the notations, one has to spend considerable amount of time surfing through the internet. Even after spending a lot of time in the internet learning

about Activity diagrams, if one wants to refresh the topics, it would take quite some time to go through all of saved favorite websites the next time. For example, tutorial 1 might have better description and notes with examples for notations 1 and 2 but not for notations 3 and 4. Similarly tutorial 2 might have better description and notes without examples for notations 3 and 4 and in order to find examples for notations 3 and 4, the search continues.

- There is hardly any tutorial available that groups and categorizes the related notations so that the user doesn't get exhausted browsing from one tutorial to another.
- There is hardly any tutorial available on Activity diagrams that interacts and evaluates the user after every topic in order to make sure that the user is quite comfortable and confident about the topic before moving on to the next topic.

The goal is to design an interactive Activity diagram tutorial that would teach someone to draw an activity diagram. A system's user interface is critical for human-computer interaction. We need to design an interface in a way that the user has minimal difficulty in using the software effectively. Our objective is to create a simple desktop interactive activity diagram tutorial (DIADT) application and the application's effectiveness will tested based on a research conducted on subjects. This project has North Dakota State University IRB approval. DIADT has lots of examples and would also evaluate and grade the knowledge acquired after every topic and after every chapter so that it keeps the interest of the user and helps the user to be confident of constructing an Activity diagram once they complete the tutorial. Most of the information and notations needed to construct an Activity diagram can be found in this application. The DIADT application acts like a framework that is extensible because, the application allows adding tutorials

of other topics into this framework without modifying the code. It is built using C# for the front end and Microsoft SQL server 2005 for the back end. The tutorial is interactive in the sense that questions are asked in a random fashion after each topic and at the end of each chapter. Some of the reasons why someone would want to use this application are:

- They are easy to install and to use.
- It stores the information locally and operates offline.
- Application has unlimited local storage and access to a local database.

Some of the features of this application are very captivating. They are:

- The notations are grouped into categories based on :
    - Level of complexity (Basic to Advanced)
    - Functionality
- It does not allow the user to skip chapters which makes it mandatory for someone to start from basics.
- There is interaction between user and system – questions will be presented in random order after each topic from each chapter and at the end of each chapter.
- One can review the tutorial as many times as they want.
- Every user will have credentials (like username and password) and can exit the application anytime they want and continue the tutorial from the chapter that they had completed (For e.g. if the user wants to take a break for some time).
- Performance chart would suggest the users to focus on chapters that they scored less.
- The tutorial has its own rules and standards. For example, the tutorial will generate a "Certificate of excellence" with the percentage scored if only the user has scored

above 90 percentages and the certificate will be send to the user's given email address.

- When a computer application is constructed, it is easily susceptible to change. In order to accommodate growing functions and changing requirements, modifying or updating an application leads to complex system. This interactive tutorial is extensible in the sense that, the database is designed in such a way that new tutorials can be added to the existing application without any modification to the front end.

The rest of the paper is organized as follows. Chapter 2 describes the related background work with respect to the existing Activity diagram tutorial applications. Chapter 3 describes the design approach with respect to the actual problem statement followed by Chapter 4 which evaluates the research based on the results from the survey conducted. Chapter 5 shows the conclusions and the future work. Chapter 6 provides the references.

CHAPTER 2. LITERATURE REVIEW

2.1. Interactivity and User Interface

There are numerous online tutorials available for Activity diagram in various different formats like Word, PDF's, Power point files, and web tutorials. Some of the free web tutorials are interactive. But there is no desktop interactive tutorial application available for activity diagram or for any of the diagrams within UML. This section presents the related works that were the base for creating the desktop interactive activity diagram tutorial application (DIADT). And the related work is categorized under three sub-sections: based on Interactivity and user Interface, based on the course content and video tutorials.

2.2. UML Tutorial Application – Crag System

The crag systems (http://www.cragsystems.co.uk/uml_tutorial/index.htm) developed a free web tutorial application to learn about Unified Modeling language (UML). The source code of this application is not available. This tutorial gives the big picture about UML and about the different kinds of diagrams available within UML.

This tutorial contains four chapters. And each chapter contains about eight to ten topics. The user interface of this tutorial is designed in such a way that it gives the course map with links to each chapter and topics. The tutorial gives all the freedom for the user to jump from one chapter to another and also from one topic to another without necessitating the user to complete the preceding topic or chapter. In other words, it allows the user to jump to any chapter they want or any topic within the chapter at any time. It does not check if the user has completed the basics before they jump to the intermediate or the intermediate before they jump to the advanced topics.

It is totally flexible and it is very easy for a beginner to jump to the advanced level topics without understanding the basics.

Figure 2.1. Snapshot of CragSystem tutorial Application

On the other hand, the user interface of "Desktop interactive Activity diagram tutorial" is designed and organized in such a way that it does not allow the user to skip chapters without completing it fully. Completing a chapter fully means that the user has successfully skimmed through the every page within a chapter where a question is asked almost after every page within the topic, and then the practice quiz at the end of each topic and finally the 'graded quiz' at the end of the chapter. In the 'graded quiz', it is mandatory to answer every question. By making it mandatory to complete a chapter before proceeding to the next chapter, the tutorial helps the user to get involved and to understand the concepts through interactivity. The Crag's system tutorial is also an interactive tutorial in the sense that;

- There is an optional quiz at the end of some of the topics.

- There is an optional test at the end of a chapter.

In the Crag's system tutorial, the optional quiz at the end of a topic is for the user to refresh the topic and is not graded. It just shows the questions along with the choices and when the user hovers over the box where there is a text that says "Mouse here for answer", it shows the answer for that particular question. Since the quiz is an optional one, the probability of the user to skip the optional quiz and the optional test is high.

In Crag's system tutorial, the questions that appear in 'optional graded test' at the end of each chapter are static i.e. every time the user takes the quiz; the same questions appear which could make it boring. The DIADT application overcomes these two issues by conducting quizzes that are mandatory and are completely randomly generated questions from the database. Also in Crag's system tutorial, there is just one type of question asked which a text-type answer with radio buttons.

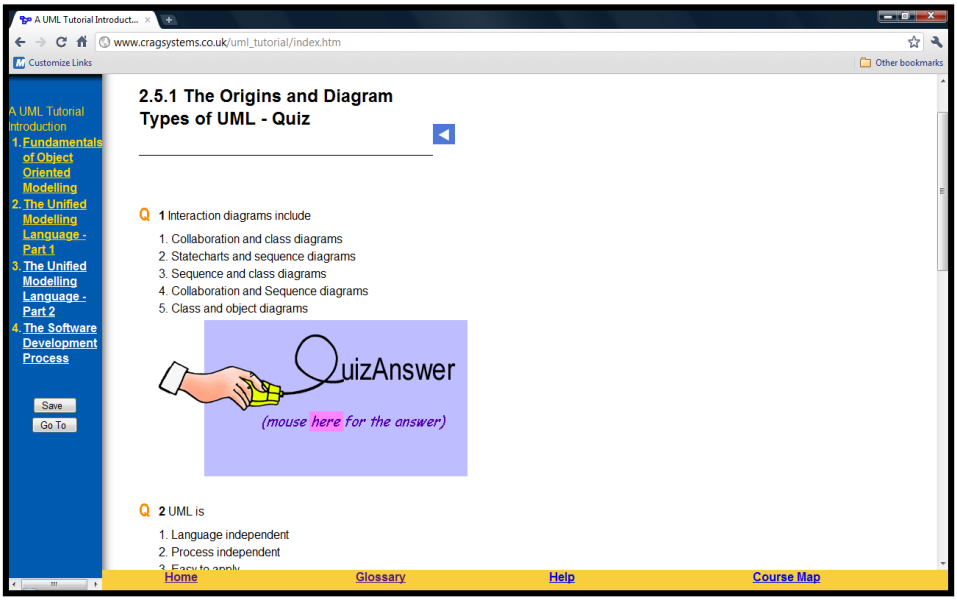

Figure 2.2. Snapshot of optional quiz at the end of a topic in "Crag's System tutorial" (Shows the question with the answer hidden)

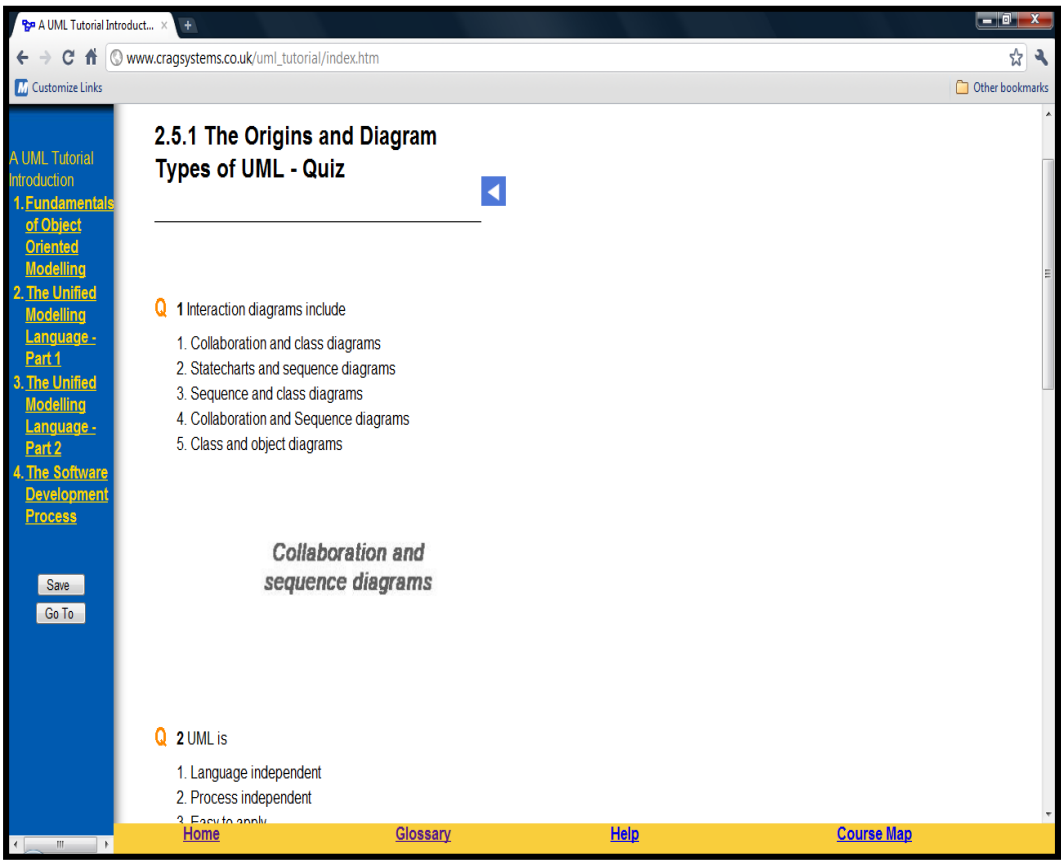

Figure 2.3. Snapshot of optional quiz at the end of a topic in "Crag's System tutorial" (Shows the answer to the question when the user moves the mouse)

In DIADT, there are six different question types that fall into two different categories. Category 1 provides the text-type answers in buttons, radio-buttons, and check-boxes. And category 2 provides the image-type answers in buttons, radio-buttons, and check-boxes.

The grading of Crag's system tutorial is too simple and not accurate. It just gives the overall percentage, number of correctly answered questions out of total questions asked, and lists the questions that the user skipped without answering. It does not give any specific details like: the user does not get to know the questions that they got wrong, and also the correct answers. Also it does not correctly display the list of skipped questions.

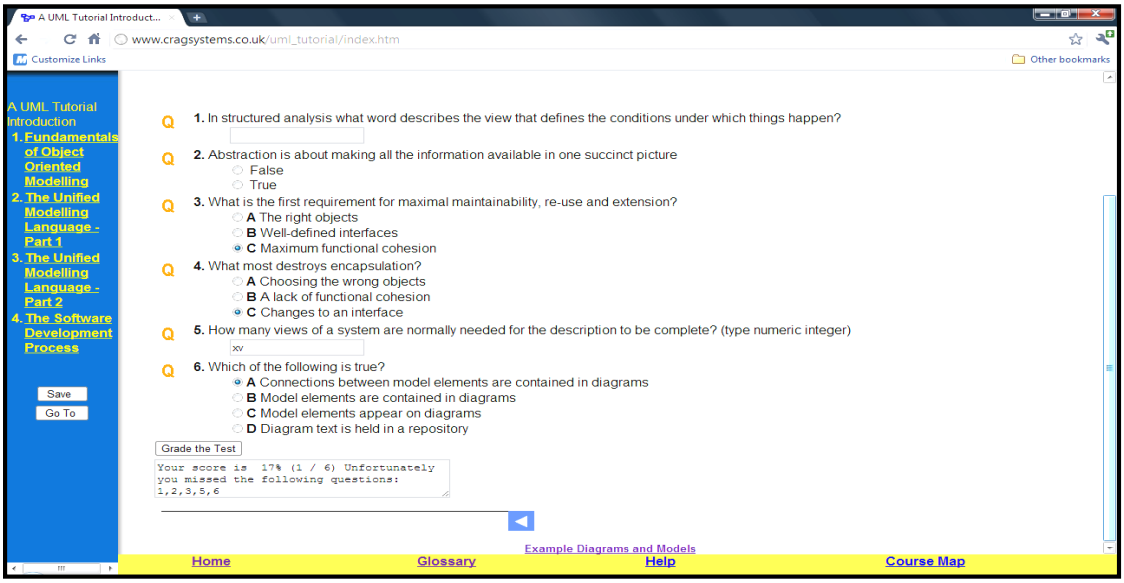

Figure 2.4. A Snapshot of optional test at the end of a chapter in "Crag's System tutorial"

The DIADT application overcomes this issue by providing detailed quiz summary at the end of each chapter and also an overall score summary after the completion of the tutorial. In the quiz at the end of each topic, the user gets to know if the answer submitted is right or wrong after every question. It provides the right answers if the user has got it wrong. The DIADT application also provides a detailed quiz summary at the end of each chapter with the following details: The total number of questions asked, the number of questions skipped, the number of right answers, the number of wrong answers, the number of partially right answers, and the score (in percentage) for that chapter. By providing such detailed quiz summaries, it helps the user to get an insight of their performance in each chapter and would help them to assess the knowledge gained.

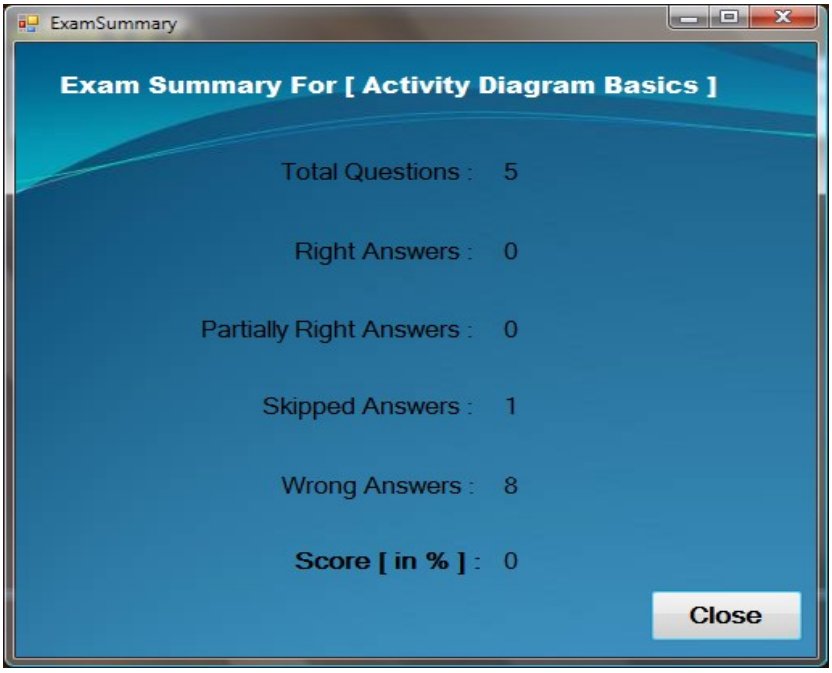

Figure 2.5. Snapshot of 'Exam Summary' from DIADT application

The DIADT application on the other hand allows the user to change their answer as many times as they want until they click the 'Submit' button. So, it's only after the user clicks the 'Submit' button, their answer is recorded for grading purpose.

It also allows the user to quit the exam anytime they want without completing it. If the user quits the exam in between (even after answering just one question), the tutorial grades the exam, showing the total number of questions asked so far and the total number of questions correct. Also in the DIADT application, if the user quits the quiz before completing all the questions, it will not show the exam summary and its equivalent to not completing a chapter. In other words, the DIADT application considers a chapter as completed only after the user completes the chapter material and the graded exam at the end of the chapter.

The DIADT application has properly organized chapters based on related topics and notations. Also it conducts an exam for grading purpose at the end of every chapter and the user

gets to know the total number of questions asked while starting the quiz which in a way helps the user to be mentally ready. By conducting exam at the end of every chapter, the user gets to focus on each chapter before they move to the next chapter. After the user finishes the exam, it pops up a window that gives the exam summary.

During multiple logins by the same user, it also shows a report at the beginning of tutorial that shows the overall performance in each chapter that would help the user to focus on those chapters that had fewer score. If the user's overall score is above 90%, it sends a "Certificate of completion and excellence" to the user's e-mail address.

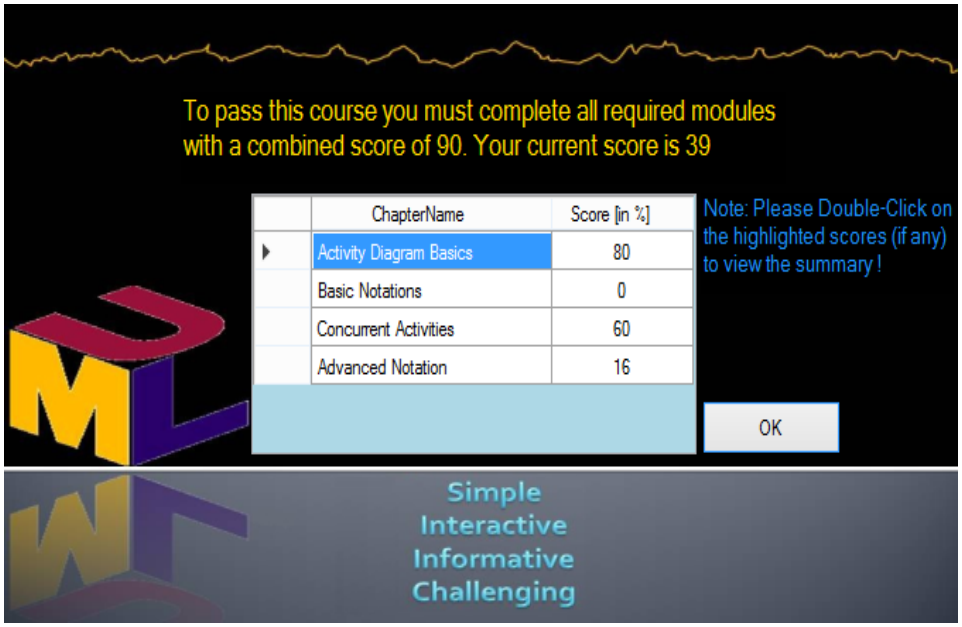

Figure 2.6. Snapshot of 'Tutorial Summary' from DIADT application

The DIADT application also allows the user to retake the tutorial as many times as they want. And another interesting feature in DIADT application is that the user can save their scores and can continue the tutorial from the chapter they completed or can retake the completed chapters in order to improve their scores before proceeding to the consecutive chapters.

2.3. Parlez UML Tutorial

Jason Gorman has developed this free web tutorial http://www.parlezuml.com/quiz.htm which helps developers on web to learn about UML, OOAD, and Agile Software development. This tutorial application is a little different than the other tutorials mentioned as it does not contain the actual material but instead contains PDF documents about related topics. It gives the basic material about UML but takes the user to other free web tutorial websites to get in depth knowledge about UML and its other diagrams. Although this tutorial is one of the most popular learning resources for UML, there is no interactivity between the user and the tutorial. Compared to other free web tutorials, this tutorial has relatively few advertisements which in a way would help the user to stay focused. This tutorial is more or less like a textbook which can get the user easily bored as it contains links to quizzes which is again a PDF document with both question and answers which is like a self-evaluation quiz. Also it has just four questions which are static and will not be sufficient enough to test the knowledge of the user.

The DIADT application on the other hand is interactive and tries to keep the user's interest by asking questions now and then. As the tutorial is organized into different chapters and each chapter in turn contains different topics or strands, it stimulates the user's knowledge gained by presenting some randomly generated questions in between topics within a chapter.

The DIADT application gives credentials for every user like a username and password. It verifies the credentials each time for a returning user. It provides the flexibility for the user to save and exit the tutorial if the user wishes. DIADT application saves the results in the database if the user clicks the 'Save' button and thus allows the user to finish a tutorial at any number of attempts.

The DIADT application sends a certificate of excellence to the user's registered e-mail id if the user's overall score in above 90%.

2.4. TutorialPoint.com

Tutorial Point (http://www.tutorialspoint.com/uml) is one of the leading free educational websites that offers online training materials on the most demanding technical and managerial subjects. This tutorial is created for educational purposes to help people who are enthusiastic about learning new technologies. Although advertising is good for commercial purpose, it makes the tutorial clumsy and distracting for the users. Tutorial Point offers a lot of advertising on its website as it has 725,000 unique visitors every month (source: Google Analytics). The user interface of this tutorial is not so attractive.

Figure 2.7. Snapshot of "Certificate of Excellence" from DIADT application

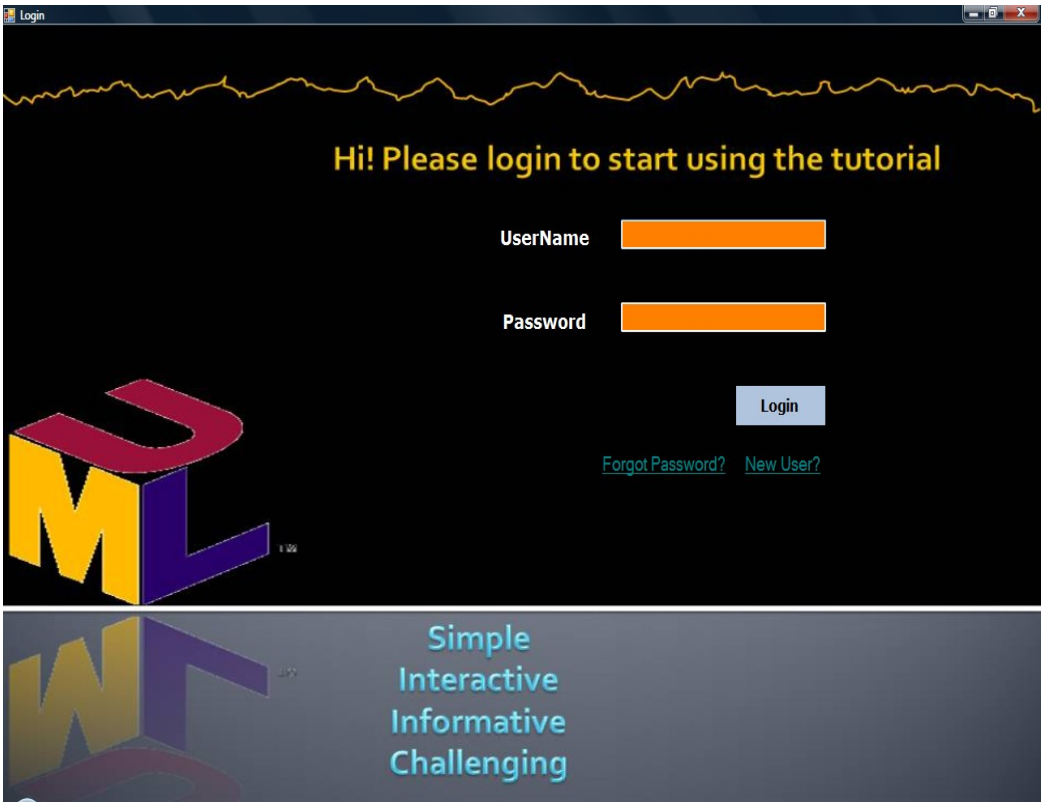

Figure 2.8. Snapshot the login page of DIAD tutorial

Some of the tutorials are just for beginners like the tutorial on UML, AJAX, etc. Also, Tutorial Point presents the contents in long paragraphs with very few examples. There is a high probability of the users not only in getting bored reading long paragraphs amidst the other advertisements but will also not find adequate information. The DIADT application on the other hand has a very simple, user-friendly, and an attractive user interface with properly organized tutorials that is easy to understand with lots of examples. The DIADT application covers information from beginner's level to advanced level.

The advantage of Tutorial Point is that it is an online free web tutorial and it has got an administrator who can be contacted in case of dead links or any other problems that the user may

face. Also Tutorial Point has some discussion forums which allow the users to post questions and to reply to questions. The DIADT application on the other hand does not have these two features.

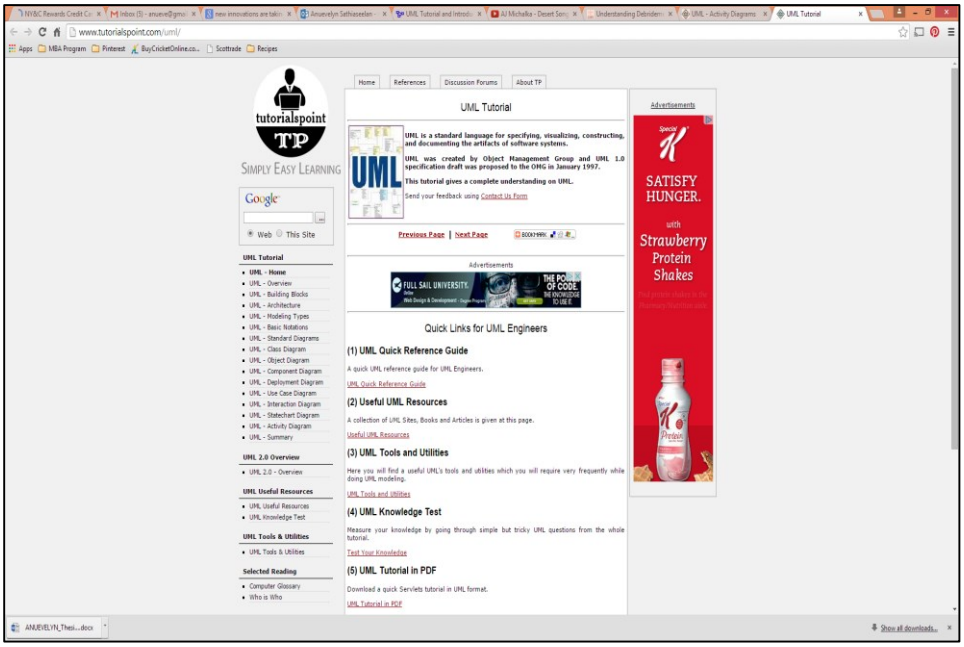

Figure 2.9. Snapshot of Tutorial Point web tutorial

2.5. Visual Paradigm Tutorial

Visual Paradigm International http://www.viswiser.com/ is one of leading providers of software solutions that enable organizations to develop quality applications faster, better and cheaper. Visual paradigm is an online training center that provides a large collection of courses in UML, Object Oriented Technologies, MVC, BPMN, SysML and more. These online courses are aimed at providing extensive practical knowledge and modeling techniques in the UML v2.2 using a pragmatic approach together with lots of examples and case studies to illustrate the usage of VP-UML (Visual paradigm's UML modeling tool). These online courses can be simply accessed via the popular web browsers and no installation of software is needed. VP-UML Tool is also available for FREE for practical work. The courses can be accessed by free subscription

with visual paradigm. The online video tutorial course on UML Activity diagram covers only the key elements in activity diagram, with examples and step-by-step demos. The DIADT application on the other hand covers most of the elements and the notations of activity diagram.

2.6. Online Video Tutorials

VTC Online University (http://www.vtc.com/products/UML_tutorials.htm) which is one of the valuable commercial training resources in the web and has developed ten thousands of online video tutorials narrated in QuickTime. And some new courses are also offered in Flash but available only for online University members. Every course on the vtc.com website contains free movies that let you assess the quality of the tutorials before you subscribe. These free video tutorials are the ones in blue links. These free video tutorials give the overview of a subject and on an average each video lasts for about 4 to 5 minutes. The course map offered by this University for UML is very much organized. One of the major constraints with this tutorial is that the full content is accessible only for a monthly membership of $30 or a yearly membership of $250

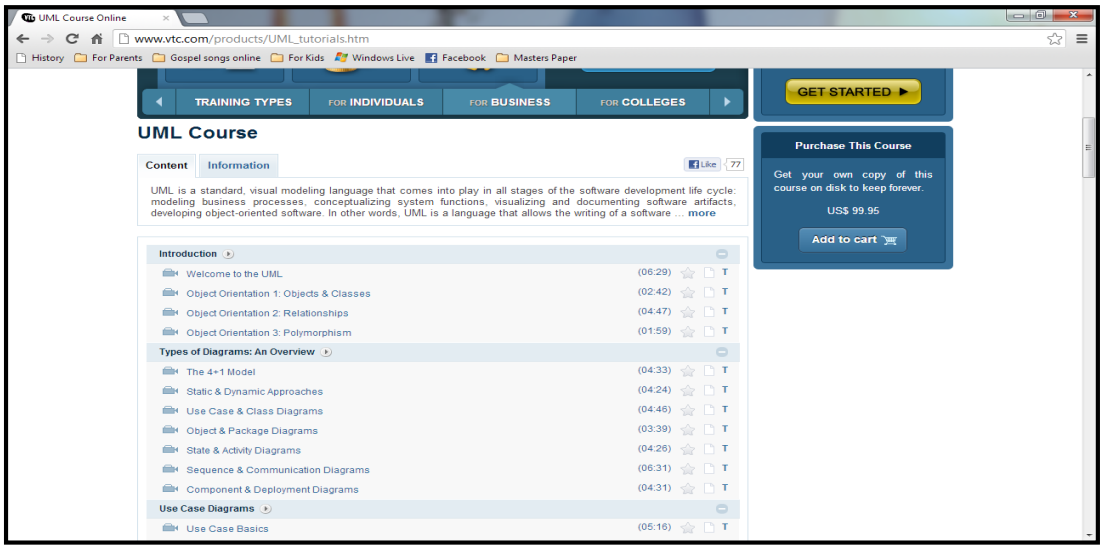

Figure 2.10. Snapshot of course map with enabled video links in blue color

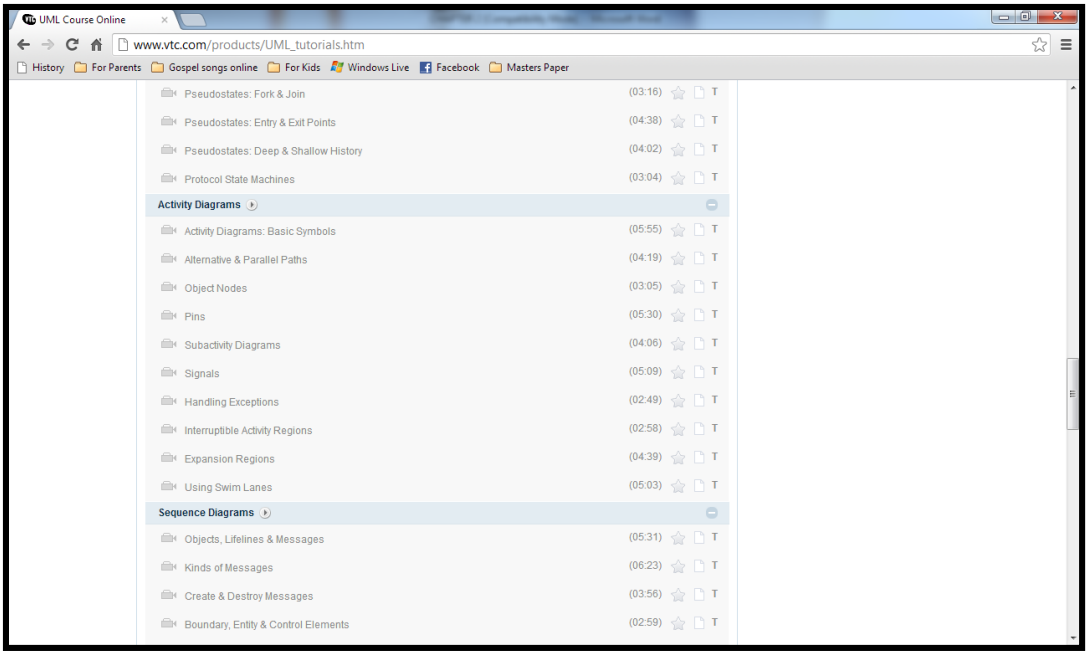

Figure 2.11. Snapshot of course map with disabled video links

2.7. DIADT Tutorial Learning style

There are different learning styles like Visual, Auditory, verbal, logical, solitary, Kinesthetic etc. And everyone has their own unique way of learning and processing new information. The DIADT tutorial pretty much takes a combination of sequential visual learning style and kinesthetic learning style. The DIADT tutorial takes a sequential learning style as every page that the user sees is nothing but an image with lots of examples, performance charts, case studies etc. The DIADT tutorial takes a kinesthetic learning style as it allows the user to complete the tutorial in multiple attempts or breaks i.e. they can complete the tutorial at their own pace.

The tutorial material of DIADT is observed from different resources like other web tutorials, PDF materials, Power points that are included in the references. The tutorial material is images that contain text and diagrams. It also contains case study examples in the last chapter of the tutorial. The future work describes about other types on contents that can added in future.

2.8. DIADT Tutorial Educational Theory

With comparison to the Bloom's taxonomy's revised cognitive domain, DIADT fits more the three categories namely remembering, understanding and application. It falls under the 'remembering' category because the DIADT tutorial conducts optional quizzes after almost every small concept or every page in a particular chapter. In addition to the optional quizzes, there is also mandatory quiz at the end of every chapter that will help the user to remember the concepts that they learned while taking the tutorial. It also falls into the 'Understanding' category because the tutorial helps the user to understand the problem statement which in turn helps them to construct the activity diagram by identifying key elements or functions that needed to be performed to solve the problem statement. It also falls under 'application' category because in addition to understanding the concepts through several examples and case studies, it helps the user to apply the concept for any given scenario at work place during project developments or in any situation where they need a visual step by step process directions. The DIADT can be extended to fit 'Analyzing' and 'Evaluating' categories.

Another educational theory called 'Structure of Observed Learning Outcome' (SOLO) also fits the DIADT to a certain level where the SOLO model consists of five levels in the order of learning. It starts from first level called 'Pre-structural' where the subject doesn't understand the concept in the tutorial. In the second level called 'Uni-structural', the subject has a basic understanding of the concept in the tutorial and tries to understand the concepts. In the third level called 'Multi-structural', the subject has understanding of several aspects of the concepts that are disconnected. In the fourth level, the subject has gained adequate understanding of the concepts in the tutorial by joining the disconnected aspects of the concepts. And finally in the fifth level called

‘Extended abstract’ the subject is able to create new ideas based on the mastery of all the concepts covered in the tutorial. DIADT fits into the first four levels of the hierarchy in SOLO taxonomy as DIADT is segregated into different chapters starting from basic concepts to advanced concepts thus enabling the subject with no understanding of the concept to gain knowledge and slowly moves to advanced concepts thus putting the different aspects of the concept together in a hierarchical level.

2.9. DIADT Tutorial Material Structure

The DIADT tutorial is divided into chapters starting from basic concepts to advanced topic because as per the SOLO taxonomy, there could be subjects who have no understanding of the concept covered in the tutorial and there could be subjects with just basic understanding of the subject. There could subjects with understanding of different aspects of the concepts in the tutorial but disconnected. Thus dividing the tutorial into chapters helps subjects with different levels of understanding.

Also the optional quizzes conducted after every concept within the chapter and the mandatory quizzes conducted at the end of every chapter helps the subjects with ‘Multi-structural’ understanding of the concepts to assess their understanding of the concepts.

2.10. DIADT Tutorial Content

The DIADT tutorial is divided into different chapters with each chapter covering from basic concepts of Activity diagram to advanced concepts with lots of examples because none of the online tutorials is organized this way. The last chapter of DIADT shows different case studies. Showing case studies in every chapter will hinder the learning of the concepts for subjects with ‘Uni-structural’ or with no basic understanding of the concept covered in the tutorial.

CHAPTER 3. RESEARCH APPROACH

3.1. Front End Architecture

This section describes the overview of the front-end architecture. It also gives a clear description of the class model that represents this front-end and explains the role of each class and how they interact together to make this work as one tutorial.

The architecture adopted was a 2-tier client server model. The client comprises of multiple layers like the user interface layer, a business layer to take care of the underlying business logic and a data adaptor layer to establish a connection with the database, which is MS SQL Server in our case.

The platform chosen to design and develop the tutorial is MS C# .Net framework. C# was chosen over other languages because of its simplicity, the C++ like syntax, its platform independent runtime support and its automatic memory management which literally cuts the development time in half. The IntelliSense is much faster and Debugging is much easier using editor like Visual Studio.

The database chosen for this project is MS SQL Server. Since the framework and the database is from the same vendor (Microsoft), the assumption is that they fit together really well and integrate seamlessly without having to install any third-party plug-ins if it were to support DBs from other vendors.

The user interface layer consists of several forms derived from windows Forms class. In the solution explorer, the forms are classified under the GUIDesign into three major categories such as Display_Login, Display_Course and Display_Results. The Solution explorer view of the same is shown below.

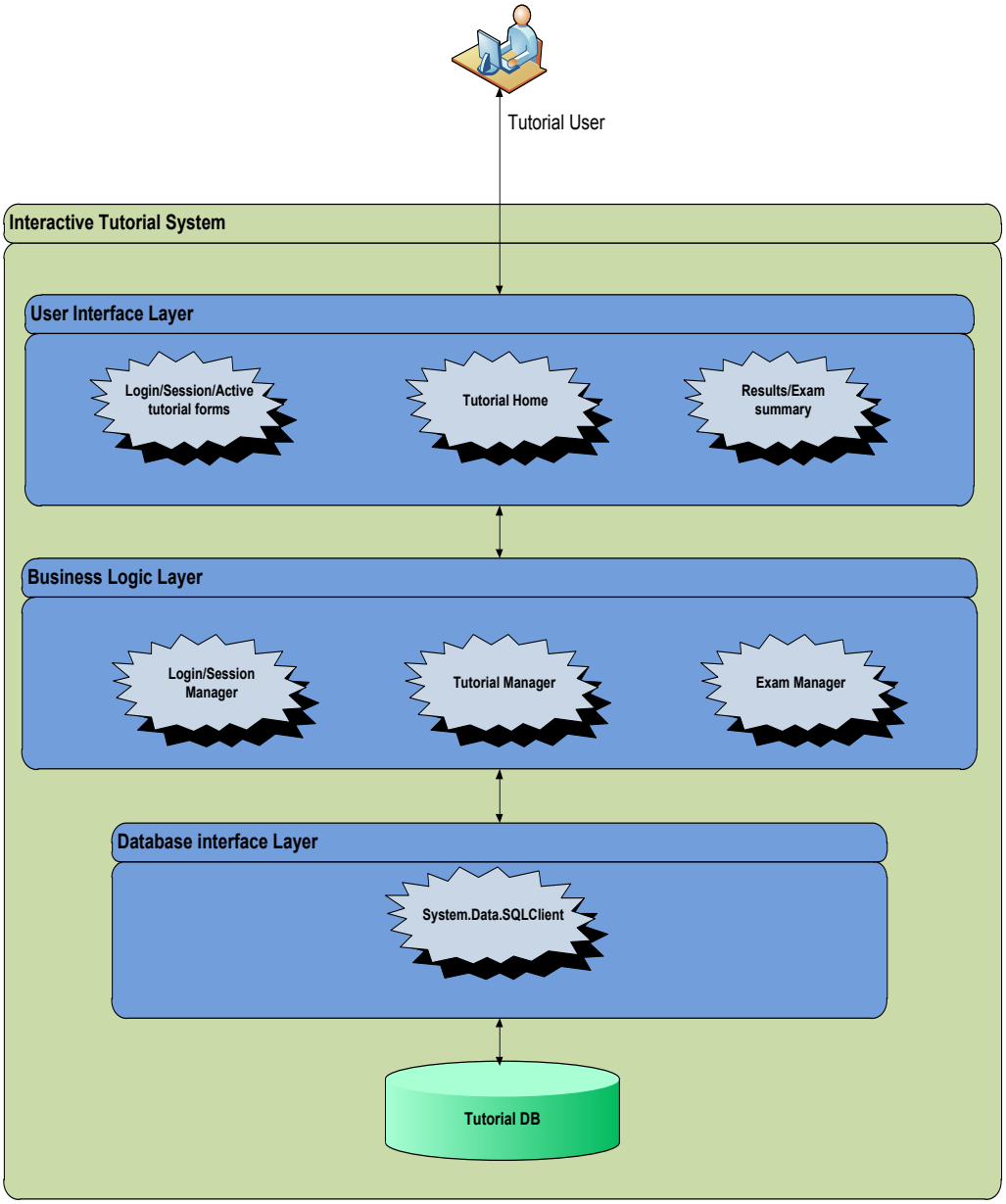

Figure 3.1. The Overview of Interactive Tutorial System

The Display_Login pretty much holds all the user interface forms related to the initial login, user registration and helper forms like forgot password, existing session info etc. Display_Course holds the forms pertaining to the core functionality like displaying the active tutorials, the actual

course contents, questions, answers etc. Display results holds the two forms, one to display the intermediate summary after each chapter and the final course completion certificate to be emailed to the user. The core of the business logic layer is classified as shown below.

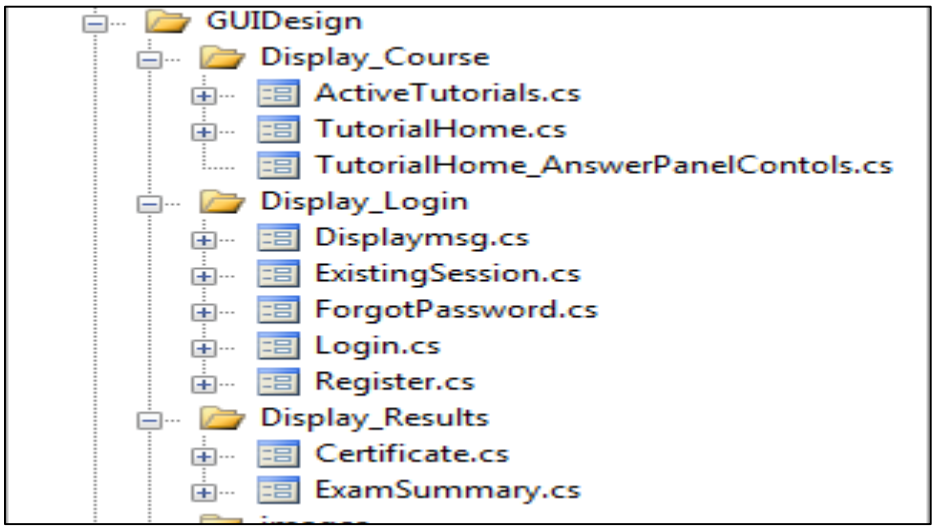

Figure 3.2. Solution Explorer view of GUI Design

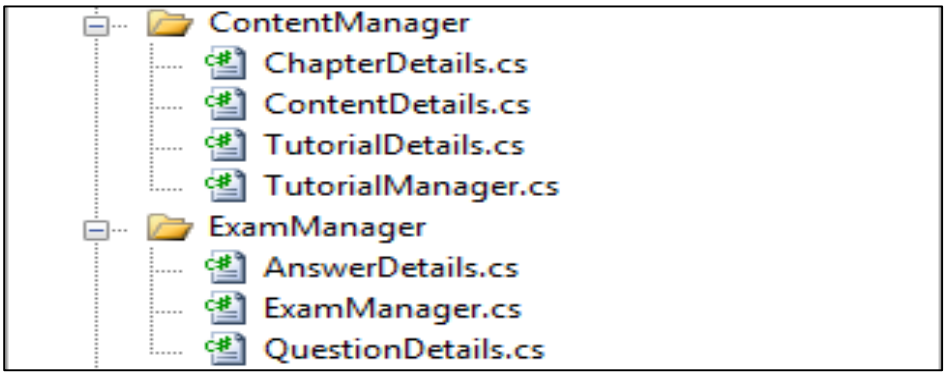

Figure 3.3. Business Logic Layer

The content manager holds the core of the contents like the actual tutorial material like the chapters, its contents etc. and the Exam manager contains the information need to conduct and evaluate the exam like the various questions and their answers etc.

It's pretty important to note that the application was written generic enough to handle any kind of tutorial, and not just the activity diagrams. There could be multiple UML tutorials

configured in the database and the application will be able to seamlessly show them to the user according to the user's choice as shown below:

There is absolutely no design nor code change required in-order to support this functionality, except for the fact that the database needs to be configured with that many tutorials.

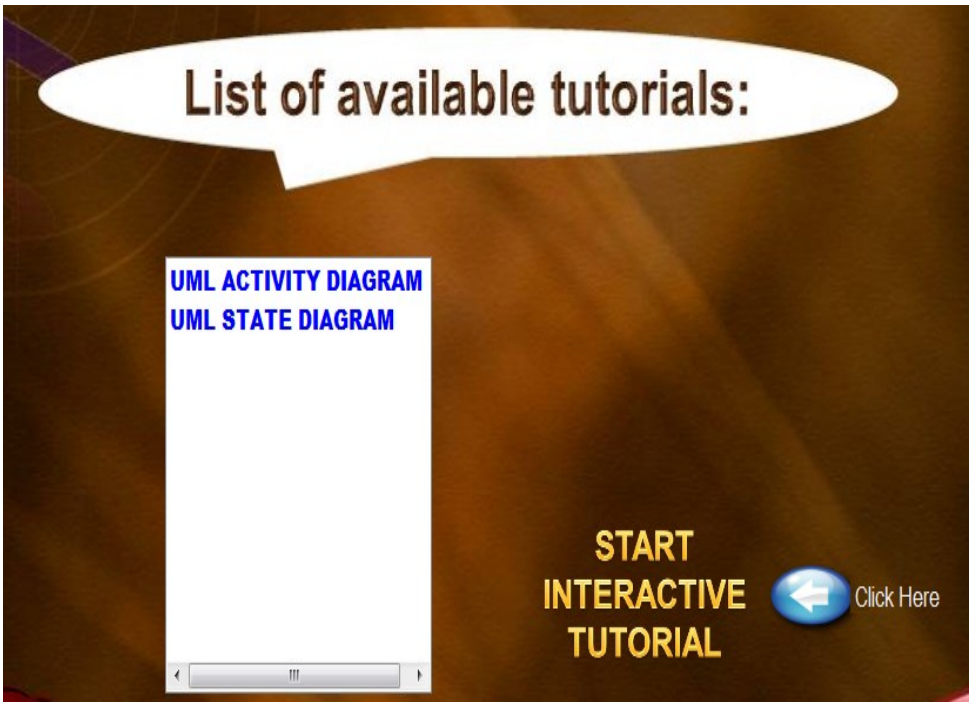

Figure 3.4. Extensibility of DIADT application

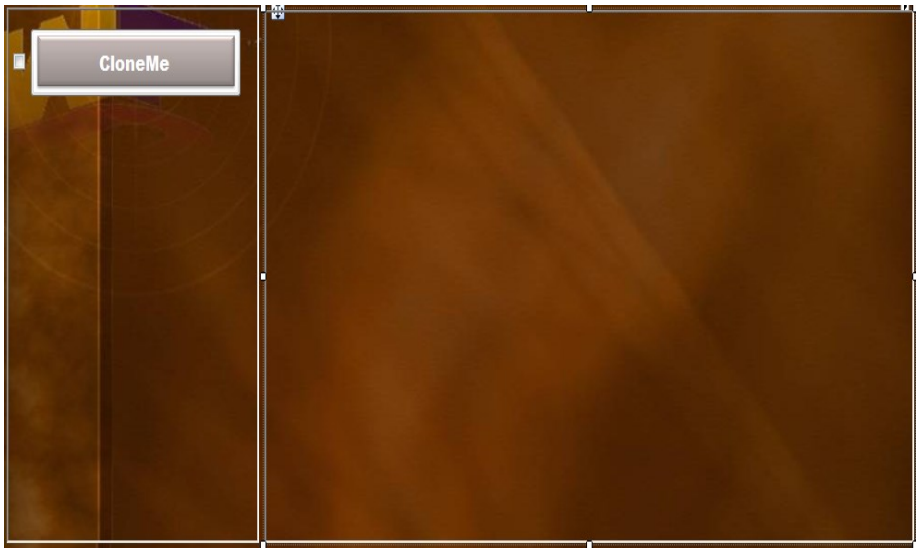

Figure 3.5. CloneMe feature in Design mode

This is a really handy feature especially when someone wants to use existing software to add new tutorials to it, but without having to know the intricacies of the design and the language used by the software.

As far as constructing a new tutorial goes, is a 2-step process. First, prepare the tutorial contents, which includes the chapters, the contents for every chapter and questions and answers for the needed chapters. Second, register these chapters, contents, questions and answers in the SQL DB. Practically speaking, this tutorial is not limited to UML topics, but can host any subject that you can think of. The only thing that ties up this tutorial with UML is the UML logo embedded on the forms. If that is removed, this will become a generic framework that can host any possible topics.

When it comes to delivering additional topics, it can be done in an incremental way by just building some sort of setup file that would copy the contents, questions\answers to the target

machine and as well as register them in the SQL DB. There is absolutely no need to re-compile and re-distribute the tutorial executable.

It's worth-while to mention how the tutorial manager shows the contents of the chapters on to the screen. The following is what is created in the design mode.

The left side of the screen is for chapter names and the application dynamically clones the "CloneMe" button to create the actual link to the chapters. This design had to be flexible enough for the fact that a tutorial can have multiple chapters and chapters can be added or removed from a tutorial without having to modify the design or code. For each chapter in the tutorial, the static "CloneMe" control is cloned using the framework's Control Factory's CloneCtrl API. The X and the Y coordinates of the cloned controls are adjusted accordingly to align and place them on the left panel. The panel is configured to have the auto scroll bars so that the users can always scroll through the chapters list in case the number of chapters exceeds the visible limit of the panel. So there are absolutely no restrictions on the number of chapters one can configure for a specific tutorial.

Figure 3.6 sequence diagram illustrates the dynamic cloning and loading of the controls. Figure 3.7 is the actual screen with the chapters populated from the database.

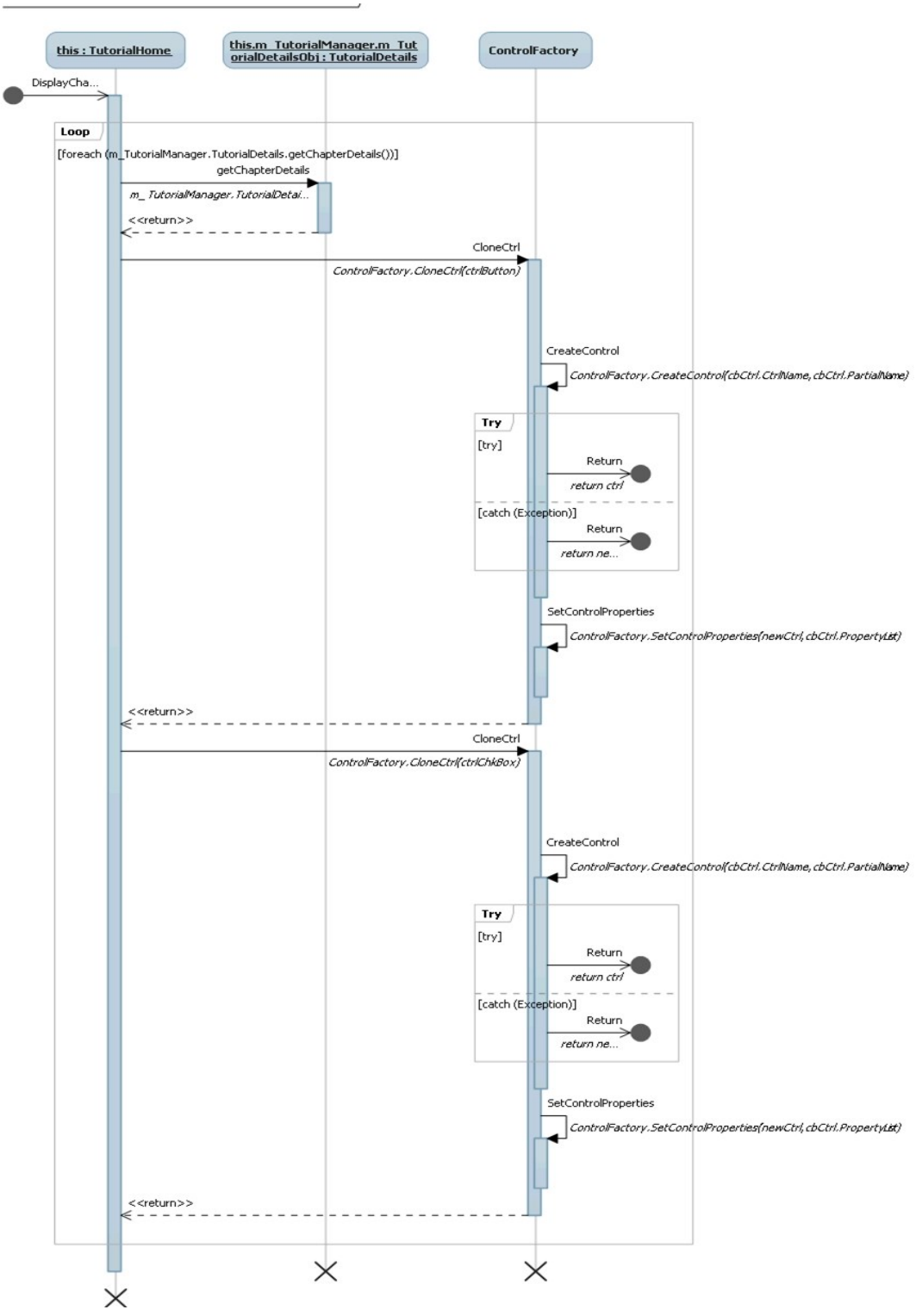

Figure 3.6. Sequence Diagram of dynamic cloning and controls

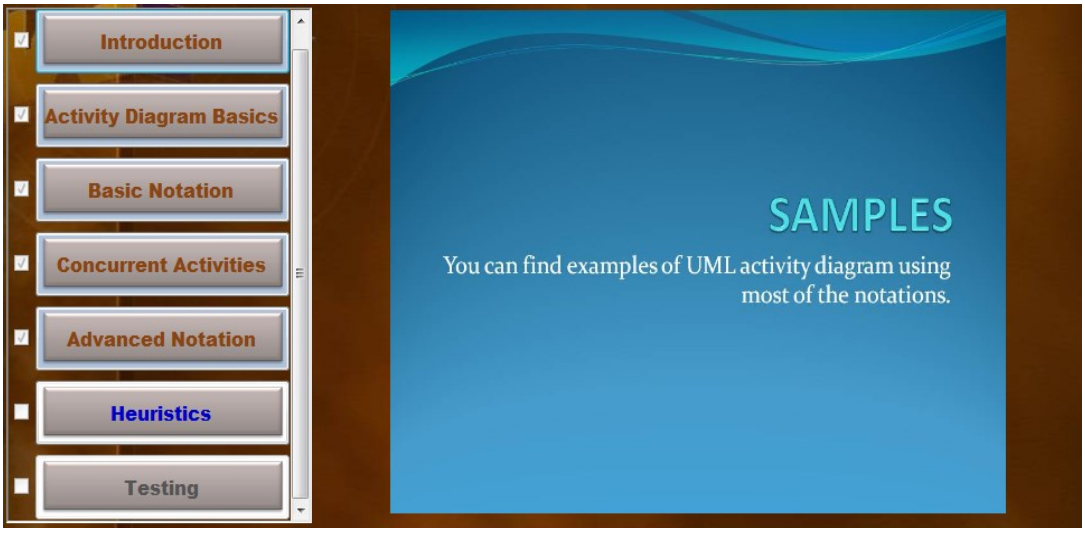

Figure 3.7. Snapshot of DIADT with chapters loaded

It is also important to note how the contents are displayed. This tutorial treats each content page as an individual image. The raw image can be in any format or can be in any size and the application has a special rendering algorithm to dynamically size the images to fit the screen.

The images are appropriately scaled up/down to fit the content page in the middle of the tutorial window. In order to properly scale the image, a multiplier is calculated to get the dimensions of the new scaled image. This multiplier is nothing but the ratio of the desired dimension to the current dimension. The algorithm multiplies each dimension of the original image by the new multiplier value to get the dimensions of the scaled image.

Most of the configuration parameters can be configured outside of the application without having to modify the code. The application is using the windows registry to store its external configuration parameters. The user has full control and access to this registry key. The registry location for this application is under HKEY_CURRENT_USER\Software\InteractiveTutorial

The sample key is shown below. The two main configurations used right now are the database connection parameters and the email configurations used to send passwords and the completion certificates.

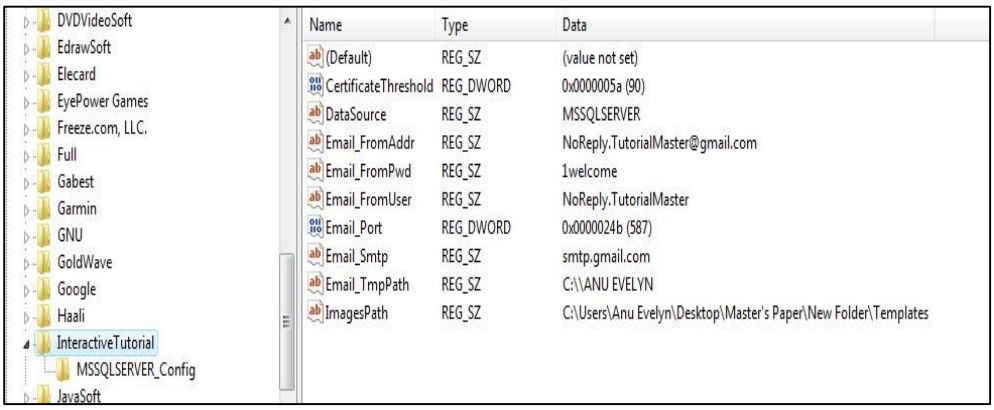

Figure 3.8. Email config info

Apart from email, a couple of other parameters like Certificate threshold and the location of the images (used during the exam time) can be configured here as shown above. The default threshold value is 90%, meaning the course completion certificate will be emailed only if the user score reaches this threshold.

A sample screen shot of the certificate is shown below. It's important to note that the displayed certificate has some buttons at the bottom left of the certificate (pointed by a red arrow) for user interaction. When the user clicks on the "Email Me" button, the application hides these controls, takes a screenshot of the certificate and stores in a temporary location in the .bmp format, uses the above configured email details and attaches the certificate to the email and sends it across. The application uses the .Net framework's mail classes defined in System.Net.Mail namespace to send mails. The System.Net.Mail namespace contains classes used to send electronic mail to a Simple Mail Transfer Protocol (SMTP) server for delivery.

Figure 3.9. Snapshot of "Certificate of Excellence "in DIADT

The following is the sample DB configuration information.

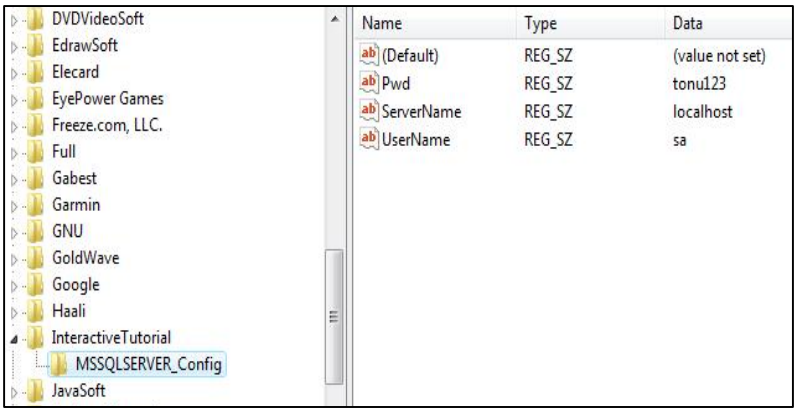

Figure 3.10. DB config info

Having looked at the overview of the application architecture, let us get into the details of the class model of the application.

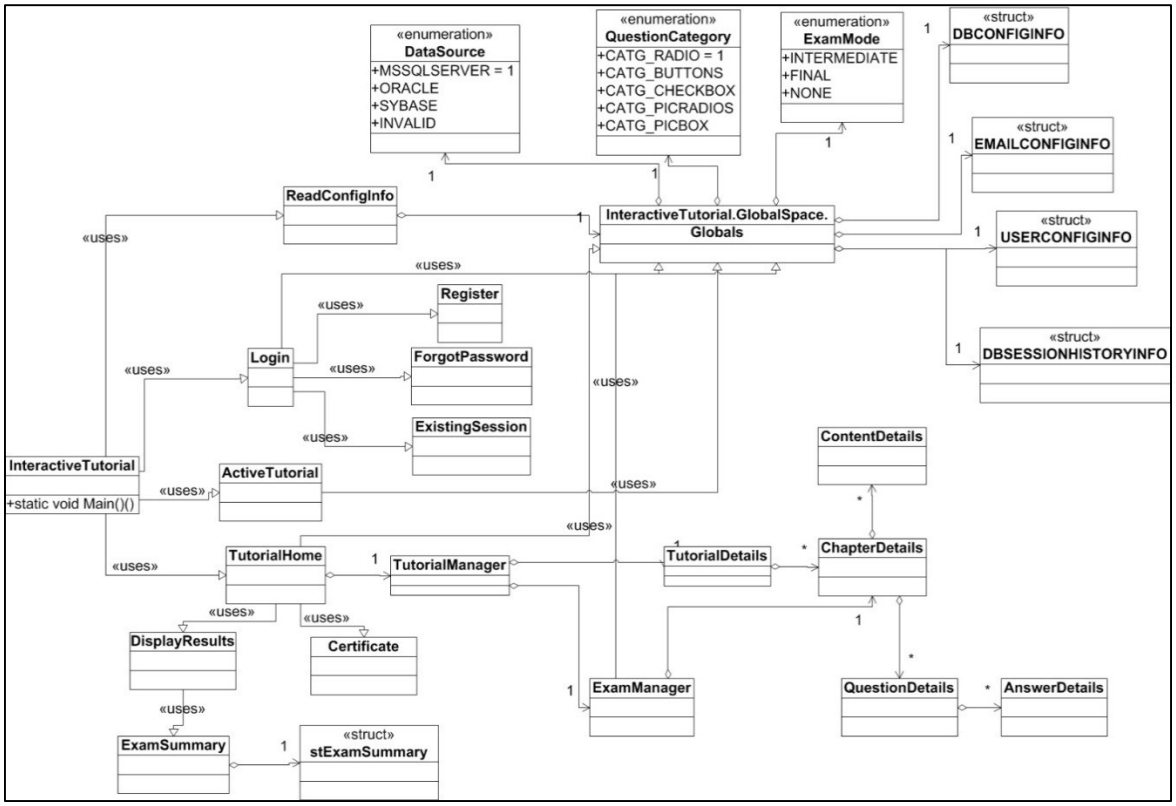

Figure 3.11. Class Diagram of DIADT application

Now let us look at the some of the key classes in this class model. The core business logic revolves around the TutorialManager class from which the relationship to the other classes starts. There is no direct inheritance used in the above model and most of the classes adopt “has-a” relationship to closely mirror the database model. Most of the classes are loosely coupled for flexibility and future enhancements.

The relationship from TutorialDetails till the AnswerDetails closely follows the database ER model so that any number of tutorials or chapter or chapter contents or other details can be added in the added in the database without affecting the design of the application.

The following sequence diagram shows the sequence of calls during loading of the tutorial from the database into the above class model. The diagram clearly shows how well the class model simulates the db schema and how easy it is to load all the contents of the tutorial in memory.

Almost all of the class models use the .Net framework's dictionary to store and map the contents into the memory. Fast lookups are critical to this project because the user spends most of the time navigating the contents of the pages in the tutorial. The dictionary object provides a way for faster lookups using keys. The dictionary can store the keys and values of any types. In our case the keys are integers for faster lookups and the values are always user defined types as shown in the class model above.

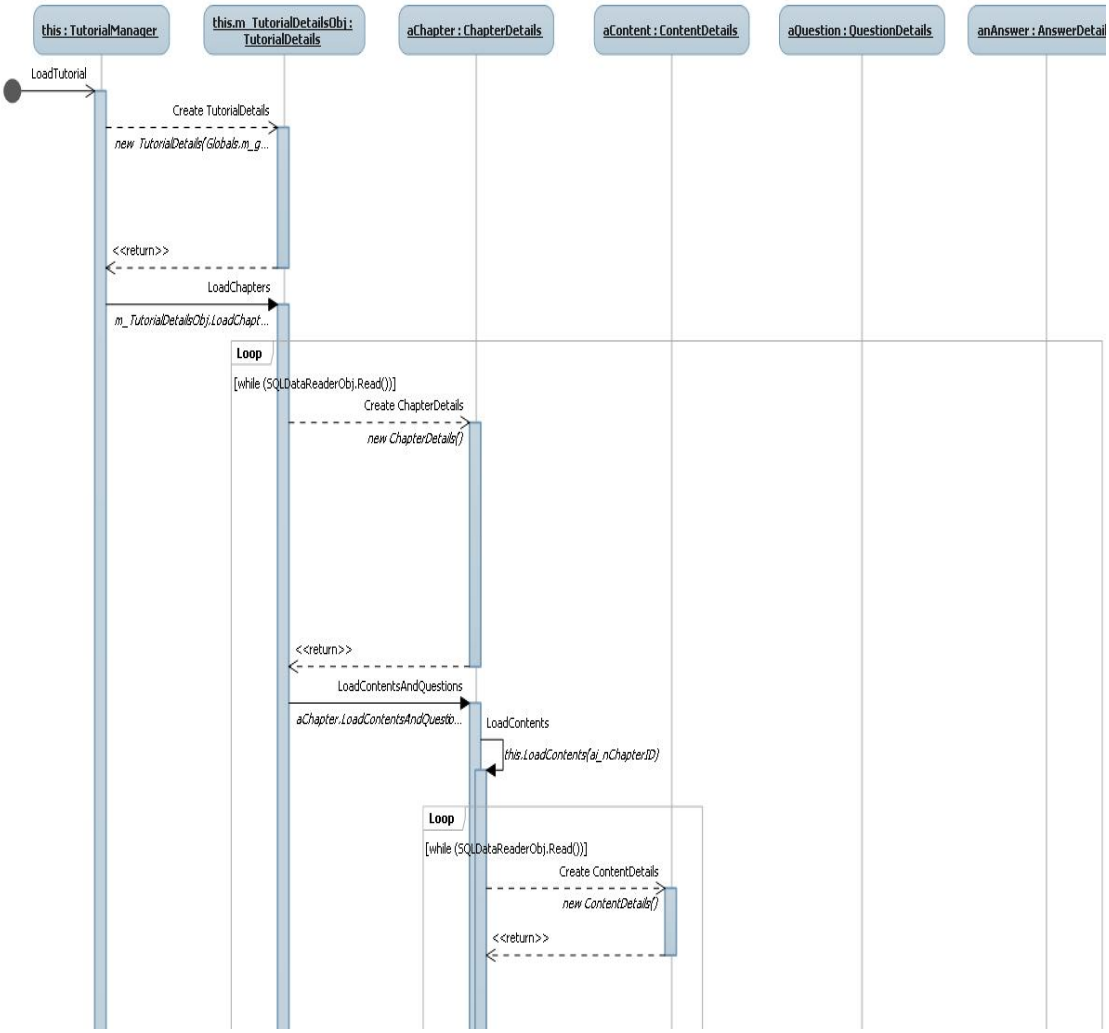

Figure 3.12. Sequence diagram of DIADT application

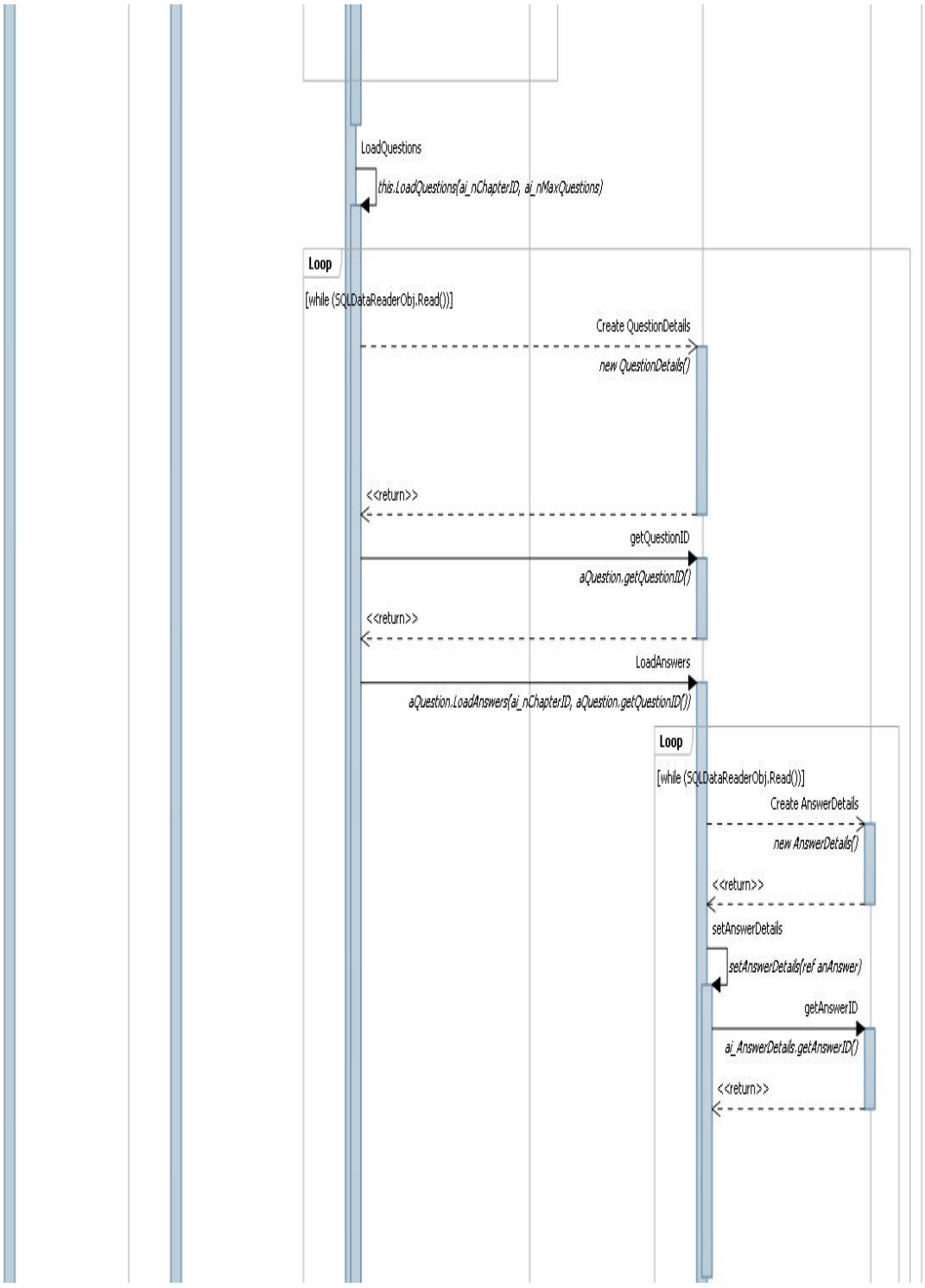

Figure 3.12. Sequence diagram of DIADT application (continued)

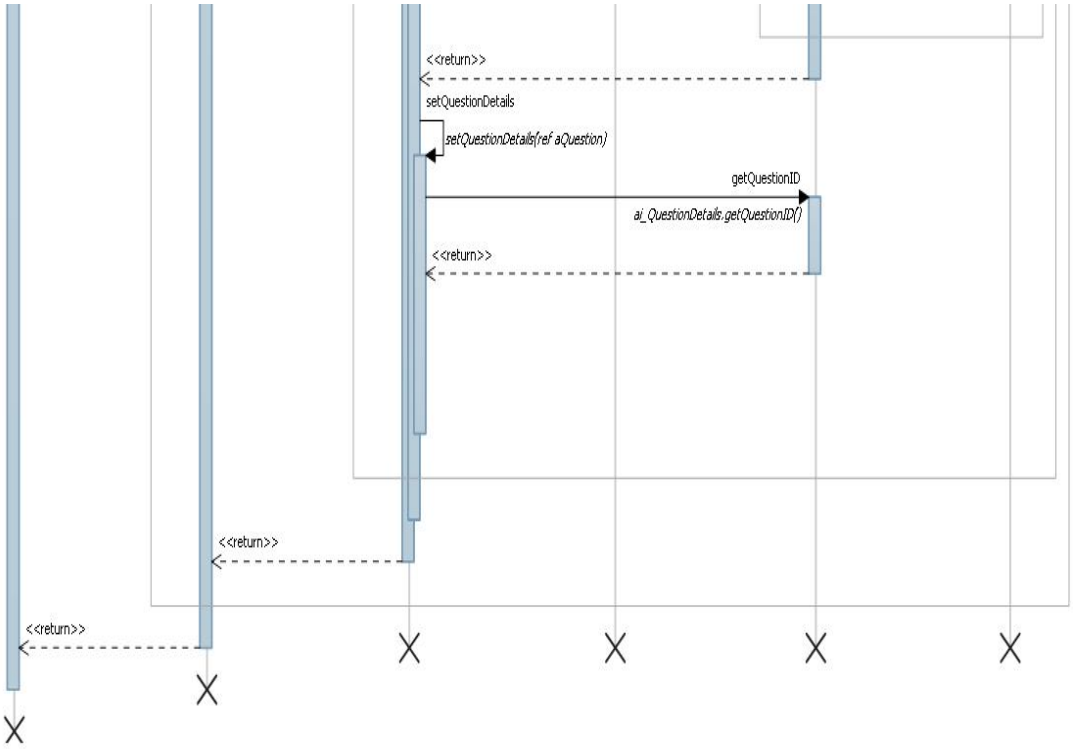

Figure 3.12. Sequence diagram of DIADT application (continued)

3.2. Database Architecture

The database architecture proposed here is a result of careful research and analysis and is intended to be reliable, extensible, and generic. The database architecture proposed here has served the desktop interactive activity diagram tutorial application very well and can be used as a framework for other interactive tutorial applications as well. The database architecture describes the organization of all the database objects, specifications, rules, processes, and naming conventions that dictate how the data is organized and stored in the database and how the data is accessed by components of a system. The proposed database architecture is designed considering the integrity, reliability, scalability, and performance issues of the tutorial application.

The tutorial application is basically built using a single database called “UMLTUTORIAL” and it contains 9 tables and roughly about 1000 records.

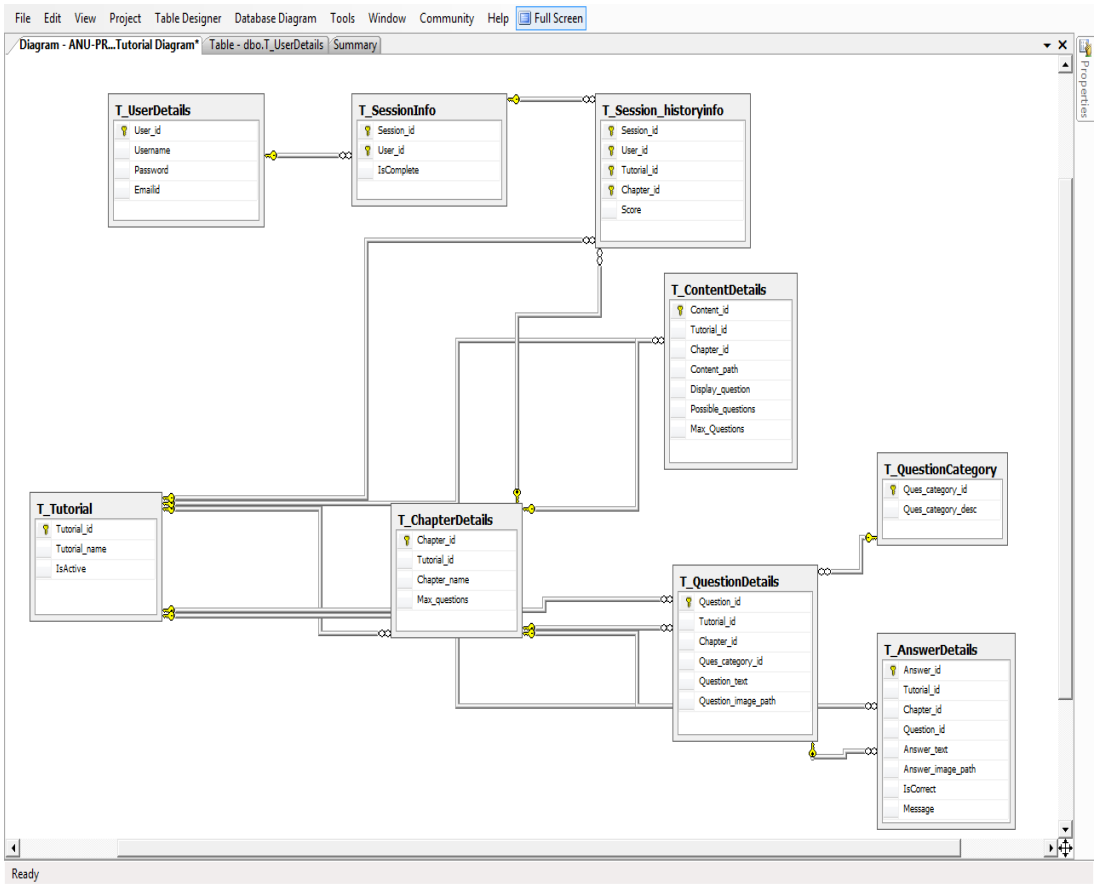

Figure 3.13. Database Naming Conventions

3.2.1. Table: T-Tutorial

T_Tutorial

Column Name	Data Type	Allow Nulls
Tutorial_id	int	☐
Tutorial_name	varchar(50)	☑
IsActive	bit	☑
		☐

Figure 3.14. T_Tutorial table structure

T_Tutorial, which is the top most table in the database hierarchy of DIADT application contains the list of all the possible tutorials that are part of DIA, and if it's currently available of not. Only those tutorials whose active state is true will be displayed in the front end of the tutorial application.

3.2.2. Table T_ChapterDetails

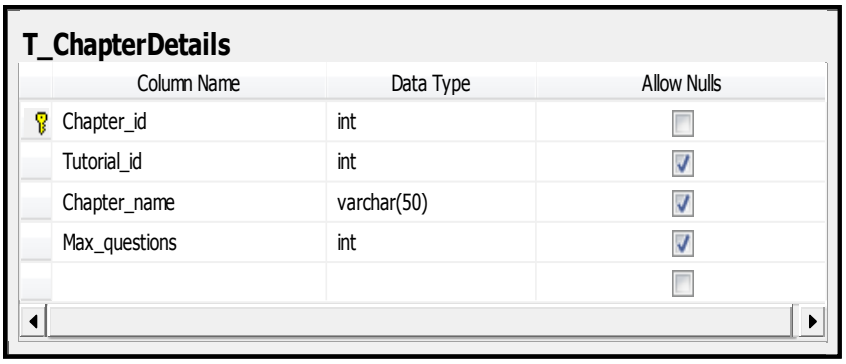

Figure 3.15. T_ChapterDetails table structure

T_ChapterDetails forms the second level of the database hierarchy and stores all the information relating to chapters for every tutorial in the T_Tutorial table. In this table, 'Chapter_id' field is the primary key which is set to the field property of IDENTITY; and 'Tutorial_id' is a foreign key that references to 'Tutorial_id' of T_Tutorial table; 'Chapter_name' field gives the name/description of the chapter; 'Max_questions' field gives the maximum number of questions that are to be randomly generated and displayed one after the other in the test conducted at the end of every chapter. Each tutorial can have 1 to many chapters. For example, there is a tutorial called 'UML Activity diagram'; and this tutorial consists of 6 chapters namely: Introduction, Activity diagram basics, Basic Notation, Concurrent Activities, Advanced notations, and Heuristics.

3.2.3. Table T_ContentDetails

T_ContentDetails forms the third level of the database hierarchy and stores all the information pertaining to the slides that are to be displayed one after the other for every chapter within a tutorial. In this table, 'Content_id' field is the primary key which is set to the field property of IDENTITY; 'Tutorial_id' is a foreign key that references to 'Tutorial_id' of "T_Tutorial table"; 'Chapter_id' is foreign key that references to 'Chapter_id' of "T_ChapterDetails" table. For example, every chapter within the 'UML.

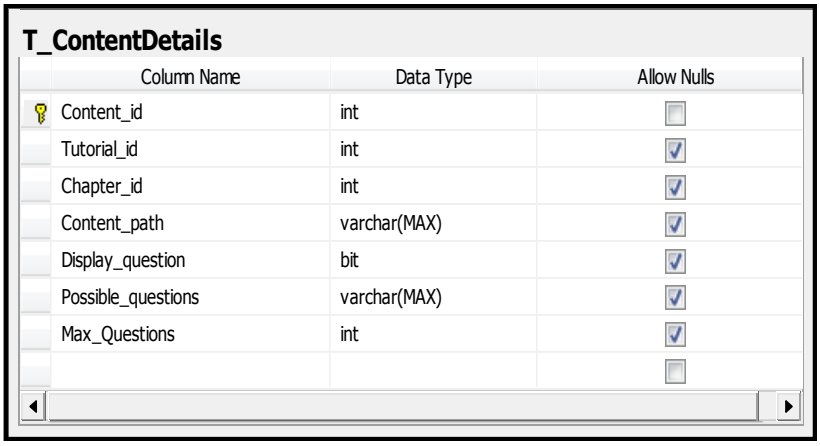

Figure 3.16. T_ContentDetails table structure

Activity Diagram' tutorial contains roughly about 5 to 40 slides These slides are stored locally in the system and only the references to the slides i.e. their path is stored in the database. This is done since large amount of text and images are involved, it becomes necessary to include formatting. In order to avoid storing the formatted documents in the database, only their references are stored in the database. Thus the 'Content_path' field stores the references to these slides that are stored locally within the system.

Each chapter within a tutorial discusses about 0 to many topics. For example, within the 'UML Activity Diagram' tutorial, the second chapter namely, 'Activity Diagram Basics' discusses

about 4 topics namely: ‘What is Activity Diagram’, ‘When to use Activity Diagram’, ‘Comparison with Flow Chart Diagram’, and ‘Advantages of Activity diagram’. As mentioned in the literature review, the interactive tutorial conducts a small quiz at the end of every topic in order to make sure that the user has understood the concepts covered in every topic. Like mentioned, the quiz generates randomly generated questions pertaining to the topic. Thus the next three columns in the table namely: Display_question, Possible_questions, Max_Questions are needed in order to conduct quiz after every topic within a chapter.

- ‘Display_question’ field is of data type bit and if it is true, then the user would see a randomly generated question in the next slide.

- ‘Possible_questions’ field is of data type varchar and stores the list of question numbers (‘Question_id’ from “T_QuestionDetails” table) related to the topic and are separated by a comma.

- ‘Max_Questions’ field is of data type integer and gives the number of questions to be randomly generated in the quiz.

3.2.4. Table T-Question Category

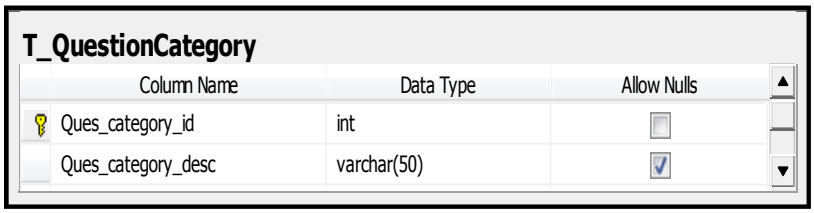

Figure 3.17. T_QuestionCategory table structure

“*T_QuestionCategory”* is also in the third level of the database hierarchy and stores the information relating to the different types of question categories present in the desktop interactive

tutorial. ‘Ques_category_id’ field is the primary key which is set to the field property of IDENTITY; ‘Ques_category_desc’ field gives the description of the question category. Currently, there are 7 different types of question categories. They are categorized in Table 3.1 below.

Table 3.1. Question Category id classification in database

Question Category id (Ques_category_id)	Question Category description (Ques_category_desc)
1	**Radio Button for Text:** 4 text type choices with only one correct answer.
2	**Button for Text:** 2 text type choices with only one correct answer.
3	**Check-box for Text:** 5 text type choices with multiple answers.
4	**Radio button for images:** 4 image type choices with only one correct answer.
5	**Button for Images:** 2 image type choices with only one correct answer.
6	**Check-box for images:** 5 image type choices with multiple answers.

3.2.5. Table T-QuestionDetails

“T_QuestionDetails” is one of the important tables in the database as it stores all the information about the questions that appear in the quiz and in the test. ‘Question_id’ field is the primary key which is set to the field property of IDENTITY; ‘Tutorial_id’ field is a foreign key that references to ‘Tutorial_id’ of “T_Tutorial” table;

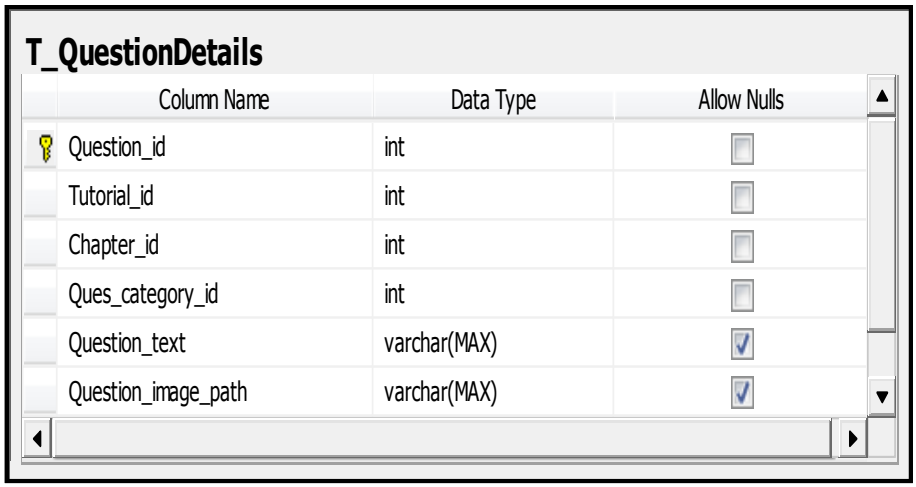

Figure 3.18. T_QuestionDetails table structure

'Chapter_id' field is foreign key that references to 'Chapter_id' of "T_ChapterDetails" table; 'Ques_category_id' field is foreign key that references to "T_QuestionCategory" table; 'Question_text' field contains the questions; and 'Question_image_path' field is an optional field and it contains the reference to the images that may appear along with the Question_text. The images are stored locally within the system.

3.2.6. Table T-AnswerDetails

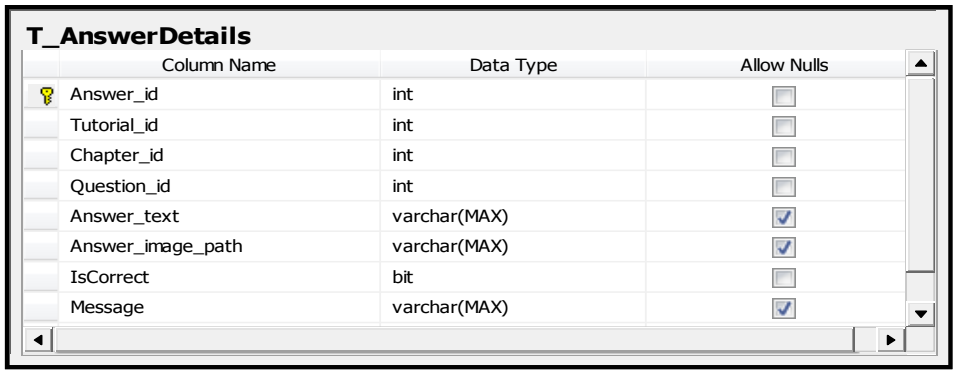

Figure 3.19. T_AnswerDetails table structure

"T_AnswerDetails" is another vital table as it stores all the answers related to the questions in the "T_QuestionDetails" table and hence very useful for grading purposes. 'Answer_id' field is

the primary key which is set to the field property of IDENTITY; ‘Tutorial_id’ field is a foreign key that references to ‘Tutorial_id’ field of “T_Tutorial” table; ‘Chapter_id’ field is foreign key that references to ‘Chapter_id’ field of “T_ChapterDetails” table; ‘Question_id’ is foreign key that references to ‘Question_id’ field of “T_QuestionDetails” table.

‘Answer_text’ field which is a string field stores the choices that are to be displayed for each question during the quiz and test time. If the choices to be displayed are images, then the ‘Answer_image_path’ field which also a string field is used. ‘Answer_image_path’ field stores only the references to the images where the actual images are stored locally in the system. ‘Answer_text’ field will be used for question categories 1, 2 and 3 and hence ‘Answer_image_path’ field will be null correspondingly. And ‘Answer_image_text’ field will be used for question categories 4, 5, 6, and 7 and hence ‘Answer_text’ field will be null correspondingly. The number of choices for each question is determined by the ‘Ques_category_id’ field of the “T_questionDetails” field. The table below shows the number of choices that will be stored either in the ‘Answer_text’ field or ‘Answer_image_path’ field in order to be displayed.

Table 3.2. Question category id relevant answer choices

Question Category id (Ques_category_id)	Field that will store the answers	Number of answer choices:
1	Answer_text	4
2	Answer_text	2
3	Answer_text	5
4	Answer_image_path	4
5	Answer_image_path	2
6	Answer_image_path	5

3.2.7. Table T-UserDetails

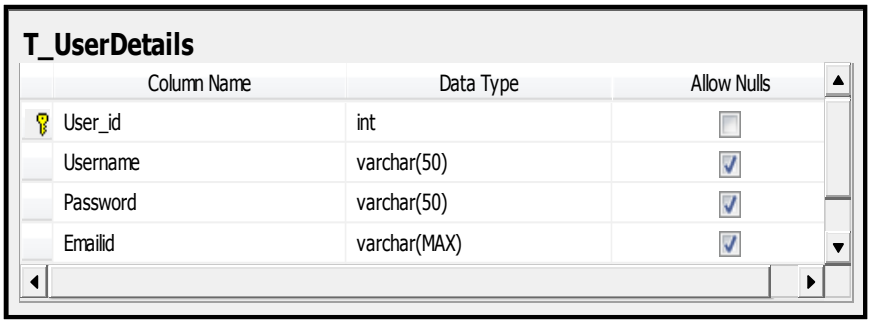

Figure 3.20. T_UserDetails table structure

"T_UserDetails" table stores information pertaining to the user's credentials. 'Answer_id' field is the primary key which is set to the field property of IDENTITY. Every user is given a unique user_id. And every new user needs to register in order to access the tutorial application. Thus by registering, a new username and a password will be set for that user. The username and password are stored in 'Username' and 'Password' fields respectively. 'Emailid' field which is an

optional field is needed if in case the user has forgotten his/her credential. The user's credentials will be sent to the registered E-mail address.

3.2.8. Table T-Session Information

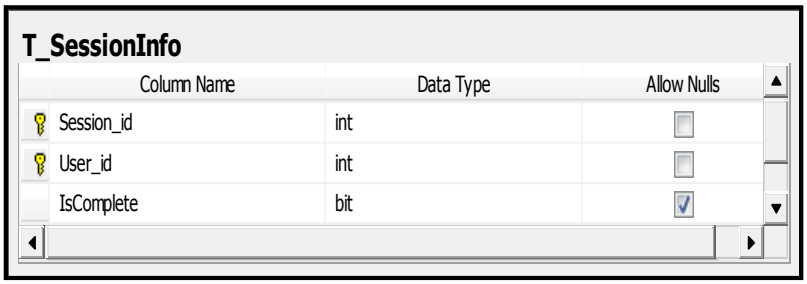

Figure 3.21. T_SessionInfo table structure

"T_SessionInfo" table collects and stores session data of every user who has exited a tutorial without completing it. 'Session_id' field and 'User_id' field together form the composite primary key; 'IsComplete' field stores the data as 'False' if the user exits the tutorial without completing it otherwise makes it 'True'.

3.2.9. Table T_SessionHistory Information

The "T_Session_historyinfo" table is used to store the history of user session information. Users can save their sessions any number of times during the period of the course. They can decide to save the session and quit half way in the middle of the tutorial and come back later to continue to the course. The application uses this table to store those intermediate session details including the tutorial and chapter ids and their corresponding scores. When the user opens the tutorial next time, the information stored in this table is used to determine the completed chapters and mark them completed on the chapter panel.

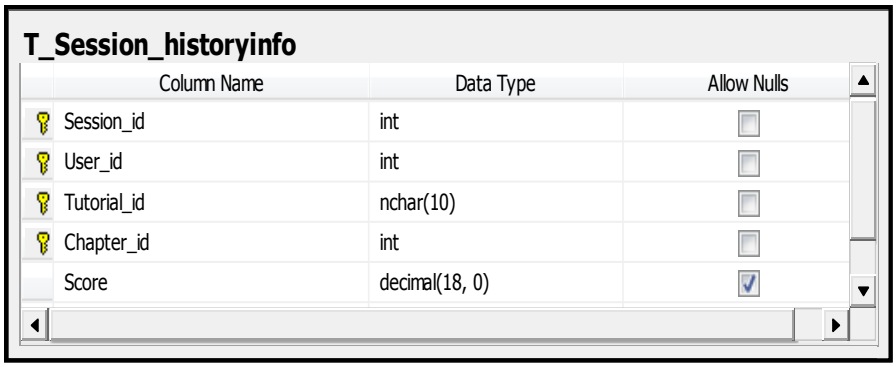

Figure 3.22. T_Session_historyinfo table structure

CHAPTER 4. RESEARCH EVALAUTION

This section of the document describes the evidence developed to describe to what extent my work solves the research problem that I described in chapter 1. The research evaluation is done based on the results of the research conducted on subjects. The subjects were asked to complete the DIADT tutorial at their own pace. After the completion of the tutorial, the evaluation is based on their answers and ratings to the survey questionnaire. Surveys are of great supplement to the overall improvement of the application.

4.1. Research Subject Selection

Basically there is no limitation on the number of subjects for the research. Anybody with computer science background and basic understanding of business processes can participate in the research. The participation is entirely the subject's choice, and they can change their mind or quit participating at any time. All participants are required to be least 18 years old as per the North Dakota State University policy involving human participants for research. Prospective subjects were send an invitation stating about the research. The following insights were given to the subjects in the invitation email.

What is the project?

I am conducting a research project to learn about the usefulness of a "Desktop Interactive activity diagram tutorial (DIADT)" which can teach someone to construct an activity diagram in an interactive way.

Who can participate?

Anybody with computer science background and basic understanding of business processes can participate in the research. Your participation is entirely your choice, and you may change your mind or quit participating at any time. All participants must be at least 18 years old.

When is it?

To participate in this project, all you need to do is send an email to anu.sathiaseelan@ndsu.edu

How much time and what I need to do?

- About 10- 20 minutes for the installation.
- About an hour to complete the interactive tutorial and
- 10 minutes to complete the survey questionnaire and it can be taken anywhere in your own computer.

Where do I need to go?

The tutorial can be taken in your personal computer or any computer which will give you the rights to install the tutorial application. All the instructions, in a step-by-step fashion will be given to you.

Who will see the responses to the survey?

Information obtained during this study that could identify you will be kept confidential. Your name will not be used in the transcripts or in results of the research. Once the results are finalized and acknowledged by the principal investigator, any kind of data or email collected from you will be destroyed. Only the principal investigator and the co-investigator will have access to the results.

4.2. Research Survey Questionnaire

The survey questionnaire basically consists of 22 questions and the questions fall under 7 different categories. Appendix A contains the survey questionnaire.

4.2.1. Category 1: Personal Information

- Highest Level of Education completed
- Relevant experience as of now:

The subject's educational background and relevant experience with respect to the tutorial is necessary in order to know their ability to understand the concept and the usage of UML Activity diagram.

4.2.2. Category 2: About Knowledge acquired

- How would you rate your knowledge on the topic 'UML Activity Diagram' before taking the tutorial?
- How would you rate your knowledge on the topic 'UML Activity Diagram' after taking the tutorial?

The subjects were asked to rate their knowledge of 'UML Activity Diagram' before and after taking the tutorial. The subjects were given 5 choices; Poor, Below Average, Average, Above Average, and Outstanding.

4.2.3. Category 3: About User Interaction

- Overall this course has stimulated my interest in the subject.

This is a very important question to know how interactive the tutorial was based on how much the tutorial stimulated the subject's interest in this topic. The subjects were to choose from 5 choices; strongly Agree, Agree, Neutral, Disagree, Strongly Disagree.

4.2.4. Category 4: About Tutorial Content

- The content is arranged in a clear, logical and orderly manner.
- The content explains the knowledge and concepts well.
- The content is of appropriate length and difficulty.
- The examples shown are good.
- The tests were based on the contents covered.

These 5 questions help to know about the orderliness, quantity, quality, and length of the tutorial. And all the 5 questions can be answered from one among the 5 choices; strongly Agree, Agree, Neutral, Disagree, Strongly Disagree.

4.2.5. Category 5: About Installation Experience

- Clarity of installation steps.
- Timeliness of application and database installation.
- Your experience with application installation.

As the tutorial is a desktop tutorial, it requires the subjects to install the database and then tutorial application. The above 3 questions will help to know the subject's experience with the installation of the tutorial. Each of the question in this category has different choices. The sample survey questionnaire is attached for reference.

4.2.6. Category 6: About Application Simplicity and Usefulness

- It was easy to use
- Application was simple

As DIADT is a desktop tutorial, simplicity and usefulness are the key factors in the overall design of the tutorial application. In this world of complexity, everybody likes simple things. The

subject's response to this category of questions will help to assess the overall design of the tutorial. The choices to these two questions vary from strongly disagree to strongly agree.

4.2.7. Category 7: About overall experience

- How much would you like to take another tutorial on this framework?
- Compared to other tutorials that you have used or is available, would you say that the DIADT application is:
- How likely are you to recommend this tutorial to someone you know may be in need to learn about UML Activity diagram?
- What is your overall experience in using the tutorial?
- Do you have any suggestions for improvements?
- Case Study to draw an activity diagram for the case study: Renovate home
- Did you use any online resources to complete the case study in question 21? If yes, approximately how much time did you spend online or other resources to complete the case study in question 21?

This category is the most important category as it gives an overall perspective of the tutorial from the subject's overall experience of the tutorial compared to other existing tutorials that they have personally used or that they know. Each question is unique on its own and hence their choices. The sample survey questionnaire is attached for reference.

4.3. Research Analysis

The research analysis is based on the empirical results collected from the 19 subjects with related studies or experience to the tutorial to analyze the interactivity, usefulness and uniqueness of the DIADT tutorial compared to the existing ones on web or any other related tutorial that the

subjects know of. The results are analyzed based on the 7 different categories of the questions in the survey questionnaire.

4.3.1. Category 1: Personal Information

The sample consists of 19 subjects. Out of which 3 of them are currently students. 7 of the subjects have completed their 4 year degree in Bachelors of Engineering, Computer Science; 6 other subjects have completed Master's in computer science/ Software Engineering; 1 subject has completed Master's in Mechanical Engineering; 1 subject has completed a PhD in computer science; 2 subjects have completed Professional degree; and finally 1 subject has completed a 3 year university degree.

Twelve of the subjects are currently working in Information technology field mostly as developers; 2 of the subjects have previously worked in Information technology field; 5 of the subjects have completed degree in Computer Science.

4.3.2. Category 2: Knowledge acquired

The knowledge acquired before and after taking the DIADT tutorial is a very important factor to determine the usefulness of the tutorial. The rating to this question is purely based on the subjects own perspective and also not based on the test results in the DIADT tutorial application. Based on the graph in Figure 4.1: Knowledge acquired before taking DIADT, a vast majority of the subjects had an "Average" knowledge about UML activity diagram. And only 2 out of 19 subjects, i.e. only 11% of the subjects had a "Poor" knowledge about UML activity diagram. And none had an "Outstanding" knowledge on the topic.

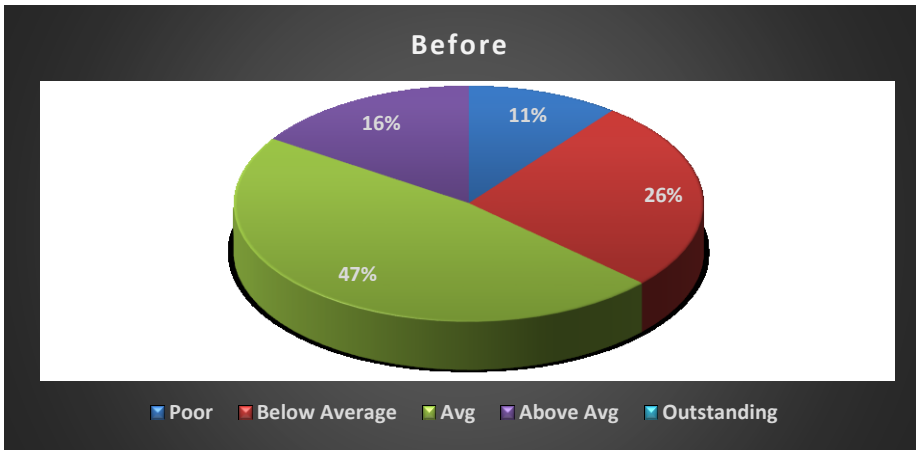

Figure 4.1. Knowledge acquired before taking DIADT

Based on the graph in Figure 4.2: Knowledge acquired after taking DIADT, a vast majority of the subjects, 74% have gained an "Above Average" knowledge about UML activity diagram. And the remaining 26% has gained an "Average" knowledge about UML activity diagram.

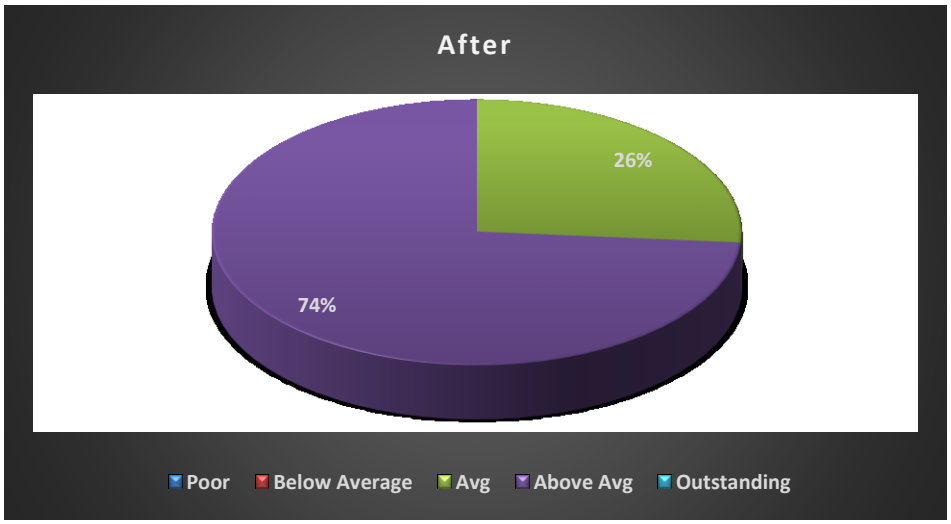

Figure 4.2. Knowledge acquired after taking DIADT

The results from the graph shows that the DIADT application has clearly improved the knowledge of the subjects from "Average" to 'Above Average" in the vast majority of the cases and from "Poor" to "Average" in two subjects.

4.3.3. Category 3: User Interaction

This category determines the level of user interaction of the DIADT tutorial based on the interest that the DIADT tutorial application stimulates on the same topic in the subjects. Based on the results from the graph in Figure 4.3: Stimulated interest in the subject, vast majority of the subjects i.e. 53% of the subjects "Agree" that the DIADT tutorial application has stimulated the interest. The goal of this DIADT tutorial application is to make learning interesting, interactive and flexible. Based on the results obtained for this category, this interactive tutorial has managed to kindle interest in the subject to majority of the candidates who experienced this tutorial.

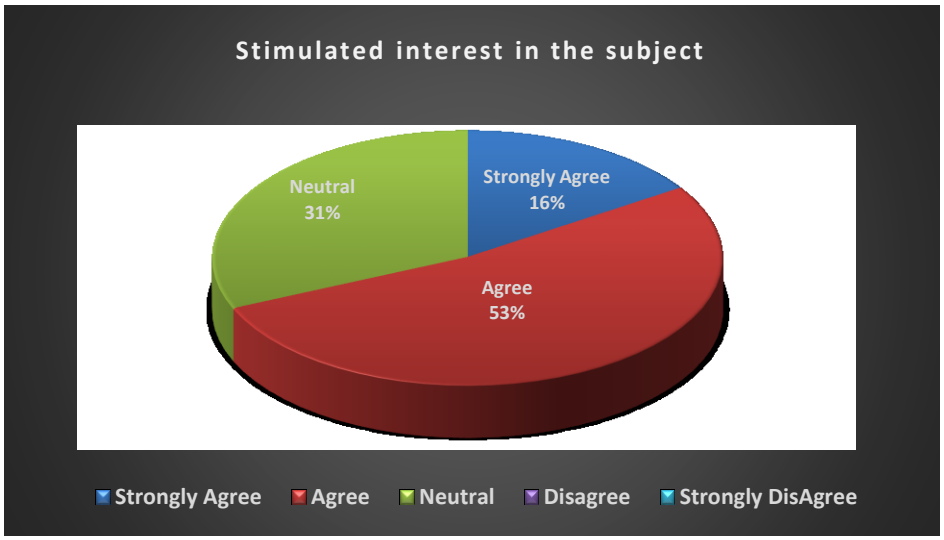

Figure 4.3. Stimulated interest in the subject

4.3.4. Category 4: Tutorial Content

This category helps to assess the content of the DIADT tutorial based on the feedback from the subjects. From Figure 4.4: Content is clear, logical and orderly, we see that 53% of the subjects "Strongly Agree" that the content was clear, logical and orderly and 42% of the subjects "Agree"

to the same. And only 5%, which is one out of 19 subjects, “Disagree” that the content was not clear, logical and orderly.

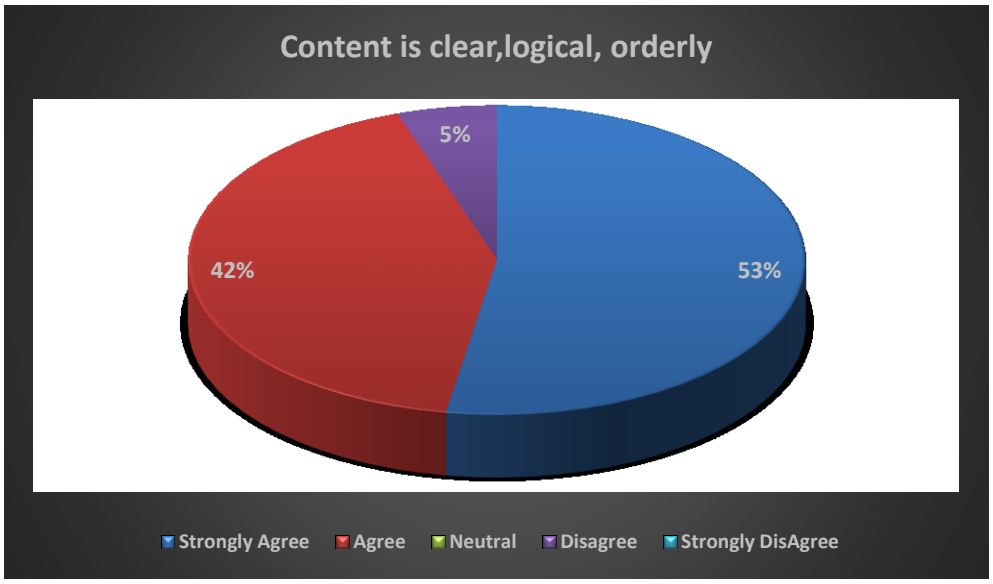

Figure 4.4. Content is clear, logical and orderly

Figure 4.5: Content explains concepts well, shows that only 5% of the subjects “disagree” and vast majority of the subjects “Agree” that the concepts of UML Activity diagram are explained well in the DIADT tutorial.

The length and the difficulty of the tutorial content plays a major role in user satisfaction. From Figure 4.6: Content is of appropriate length and difficulty, we see that 47%, a noticeable percentage of the subjects are “Neutral” that the content is of appropriate length and difficulty, although 37% of the subjects “Agree” to that and only 5% of the subjects “Disagree”.

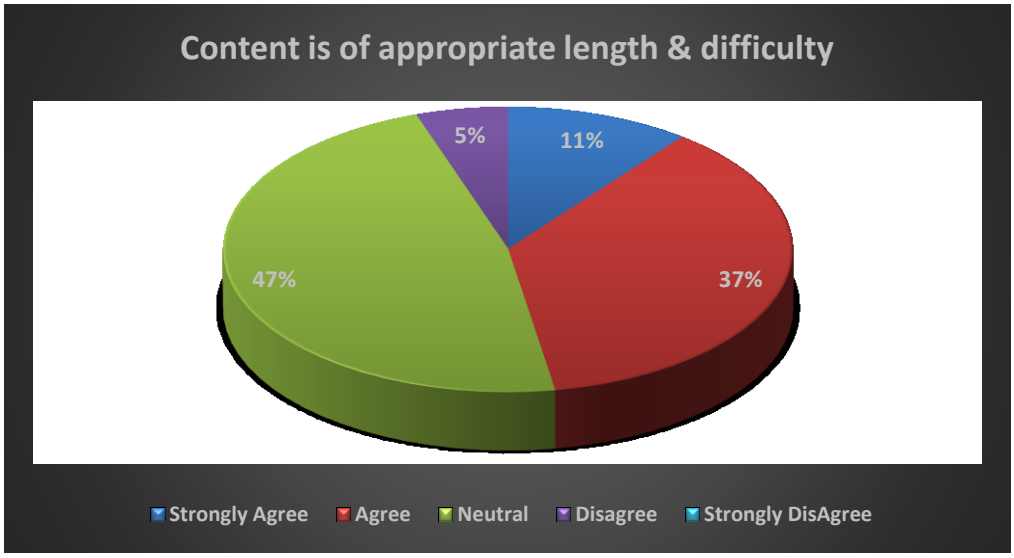

Figure 4.5. Content explains concepts well

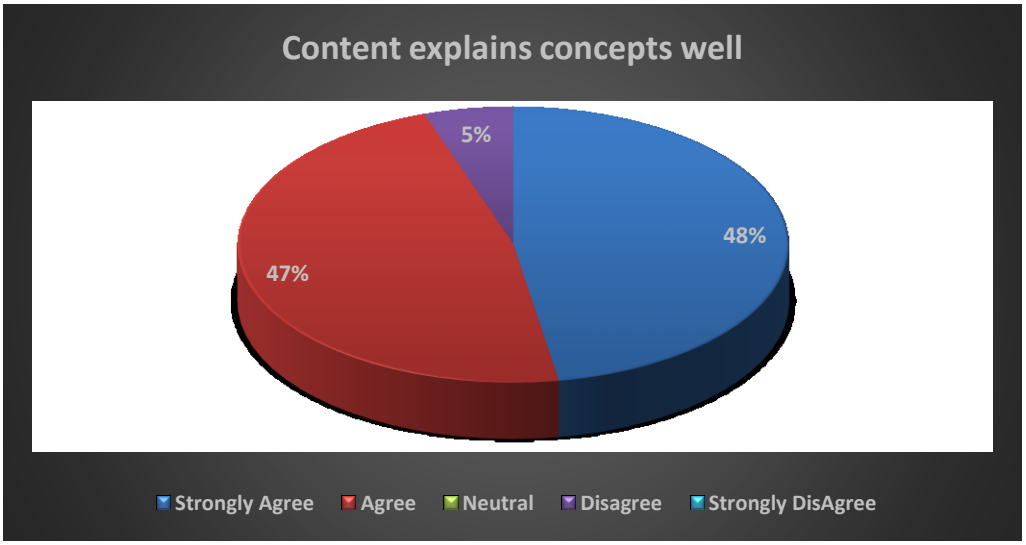

Figure 4.6. Content is of appropriate length and difficulty

"Figure 4.7: Examples are good", shows that the examples of UML Activity diagram shown in DIADT tutorial are good except 5% of the subjects that "Disagree" to that. "Figure 4.8: Tests were based on contents" shows that all the 19 subjects "Strongly Agree" or "Agree" the tests

conducted during the entire course of the DIADT tutorial was based on the content presented in the tutorial.

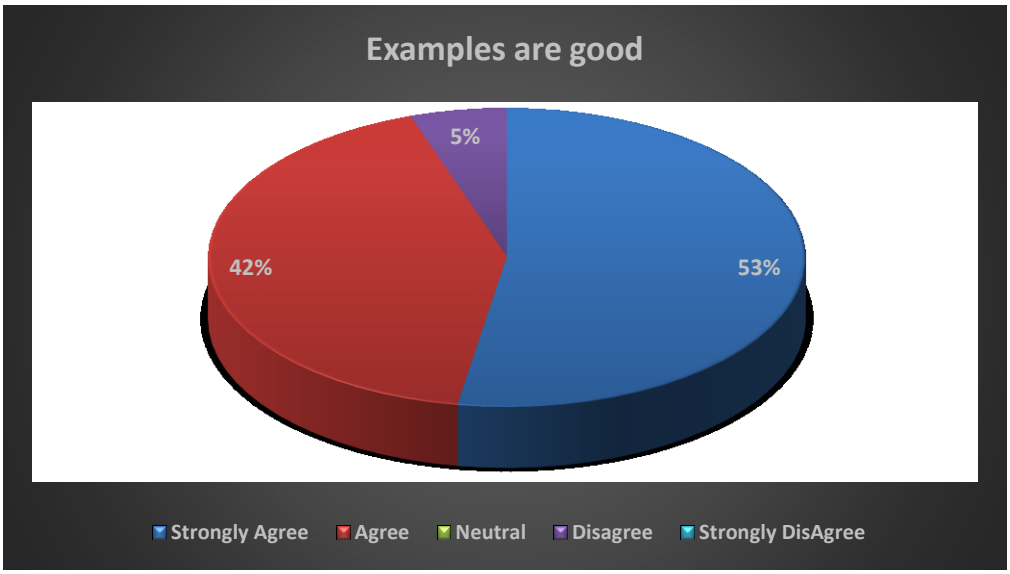

Figure 4.7. Examples are good

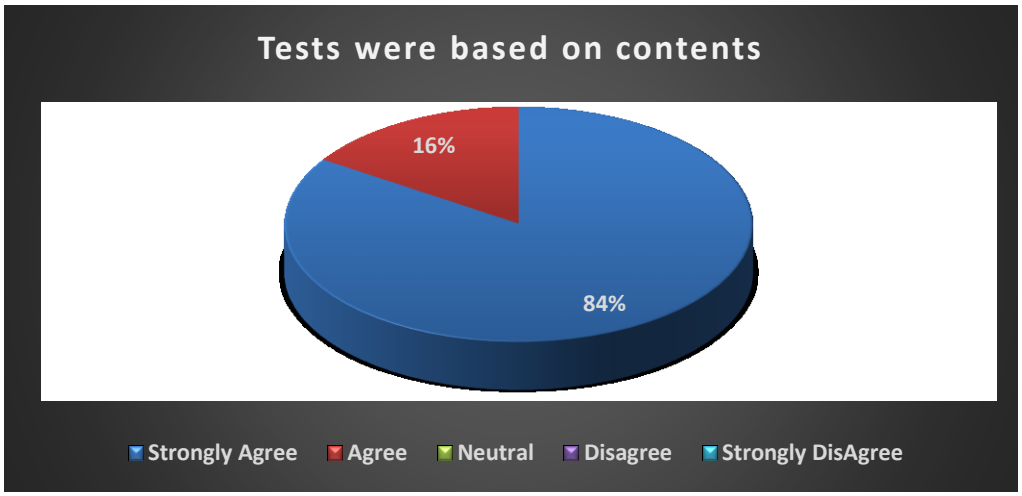

Figure 4.8. Tests were based on contents

Thus based on the empirical data collected from the survey conducted and from the graphs that were derived based on the data collected, we see that the vast majority of the subjects are

satisfied with the tutorial content except for a noticeable 47% of subjects who were neutral about the length and difficulty of the tutorial.

4.3.5. Category 5: Installation Experience

This category 5 that deals with subjects experience in the installation of the DIADT tutorial application brings out quite the inconvenience that the subjects encountered because of the time factor. From Figure 4.9: Clarity of Installation steps, although 84% of the subjects found that the installations steps were clear, we also see from Figure 4.10: Timeliness of Installation that 55% of the subjects found the installation process "Somewhat time consuming".

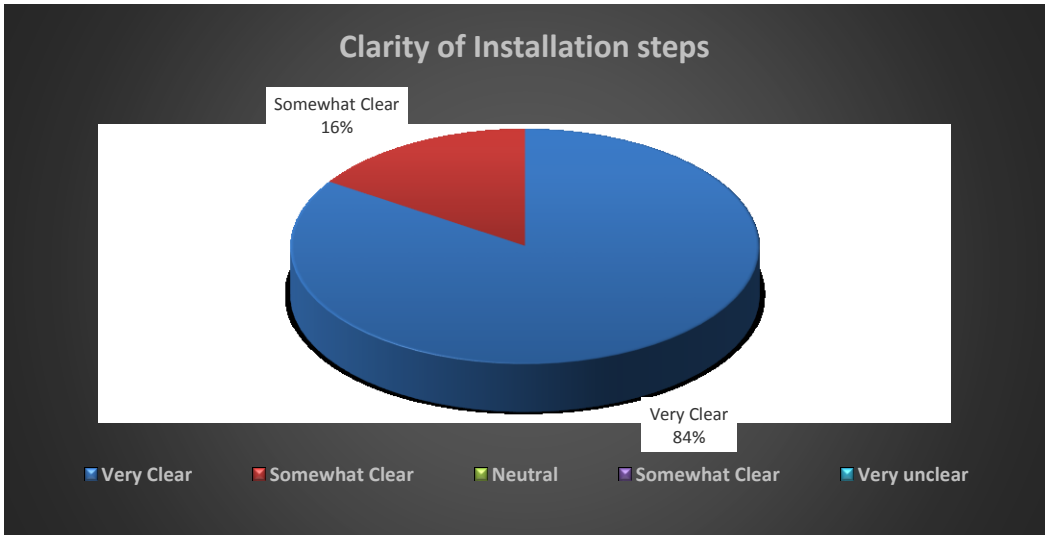

Figure 4.9. Clarity of Installation steps

We see from Figure 4.11: Experience with Application Installation that 58%, a vast majority of the subjects were "neutral" about their experience with Application installation. Although 84% of the subjects found the installation steps to be "very clear", the installation was time consuming. Time factor plays a major role in any business and for every individual. Although majority of the subjects are currently working in "Information Technology" and have related experience with

respect to this tutorial, 21% of the subjects found their experience with installation as “Hard” and the remaining 21% found their installation experience to be “Easy”.

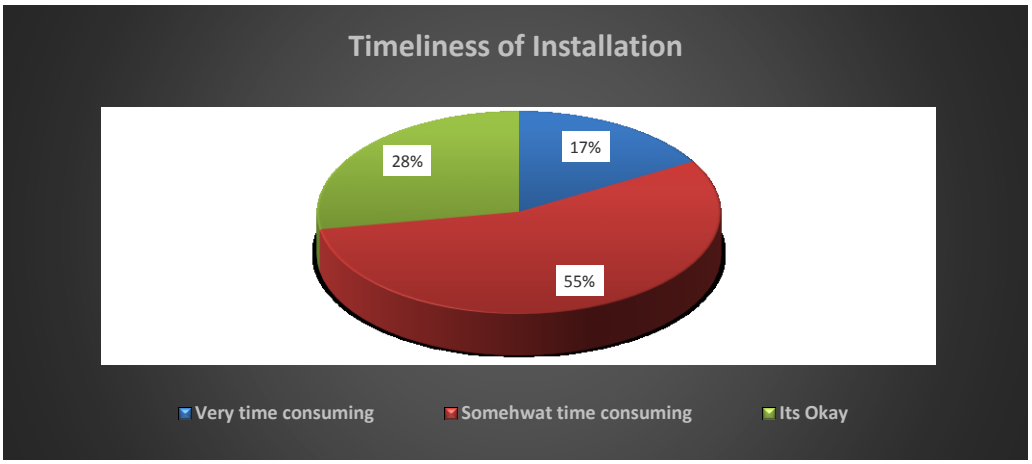

Figure 4.10. Timeliness of Installation

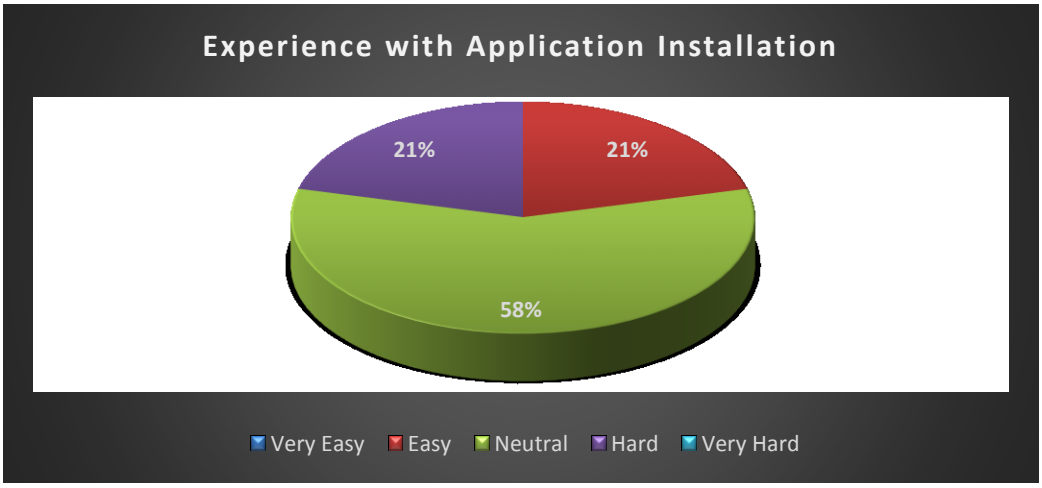

Figure 4.11. Experience with Application Installation

Thus one of the drawbacks of DIADT tutorial application could be with the installation of the application in their local machine as the installation process was “Somewhat time Consuming” especially because of the need for database installation as DIADT is a desktop application that

requires a local database to access all the contents of the tutorial, and to interact with the subjects through question and answer session.

4.3.6. Category 6: Application Simplicity and Usefulness

Category 6 helps to determine the simplicity and the ease of use of DIADT tutorial application. From both Figure 4.12: It was easy to use and Figure 4.13: Application was simple, we see that the graphs are same and that all the subjects unanimously "Agree" or "Strongly Agree" that the DIADT tutorial was easy to use, and was simple without being complicated although there is a lot of interaction between the subject and the tutorial throughout the tutorial.

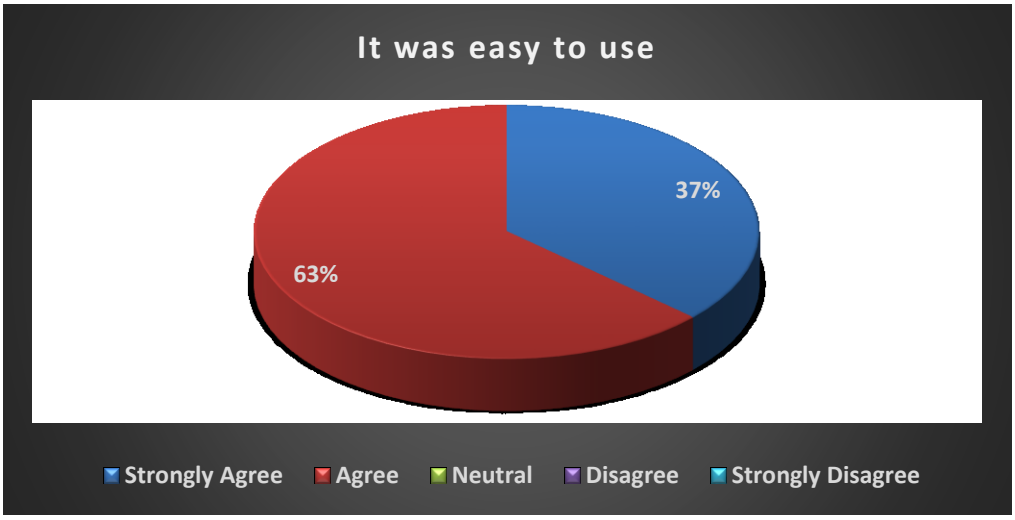

Figure 4.12. It was easy to use

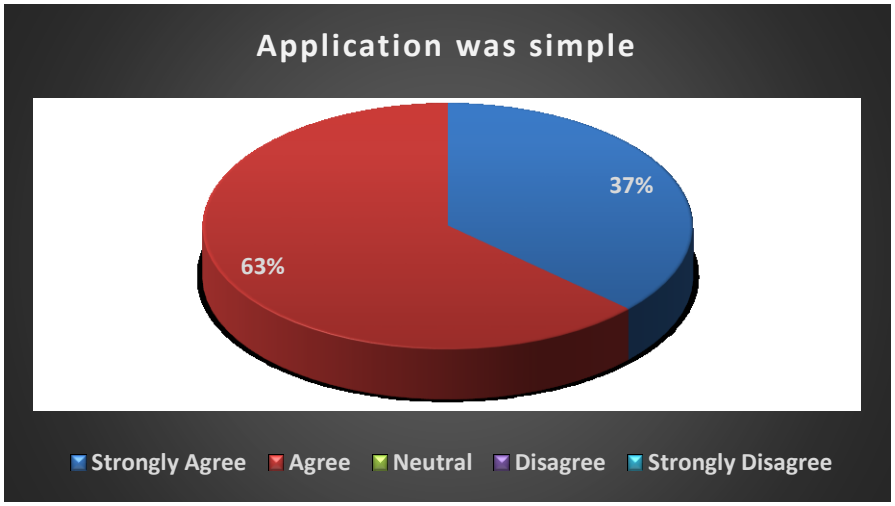

Figure 4.13. Application was simple

4.3.7. Category 7: Overall user experience

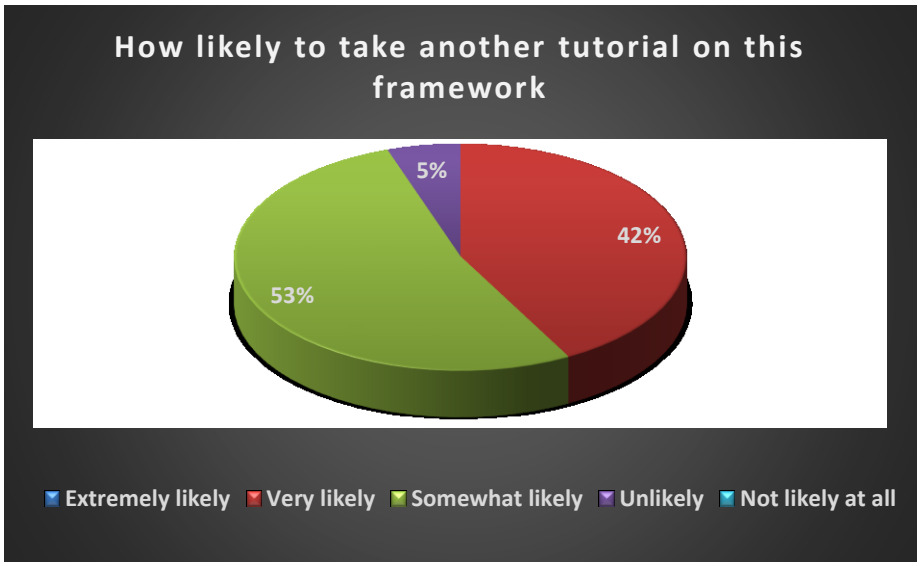

Figure 4.14. Likeliness to take another tutorial on this framework

Category 7 gives us the overall user experience with DIADT tutorial and there are about 7 different questions including a case study on UML activity diagram. From Figure 4.14: Likeliness to take another tutorial on this framework, we see that about 53% of the subjects are “Somewhat

likely" and 42% of the subjects are "Very likely" to take another tutorial on this framework which leaves only 5% of the subjects that are "Unlikely". The "Somewhat likely" category could be because of the time consuming factor that the subjects experienced with the installation. Since a relatively higher percentage of the subjects are "Very likely" to take another tutorial on this framework, it gives a positive feedback on the overall framework of the DIADT tutorial application.

From Figure 4.15: DIADT in comparison to other tutorials, We see that 63%, a significant portion of the subjects found DIADT to be "Somewhat better" compared to other available tutorials that they know of. Suggestions from the subjects unanimously preferred a web tutorial or preferred to have avoided the installation process.

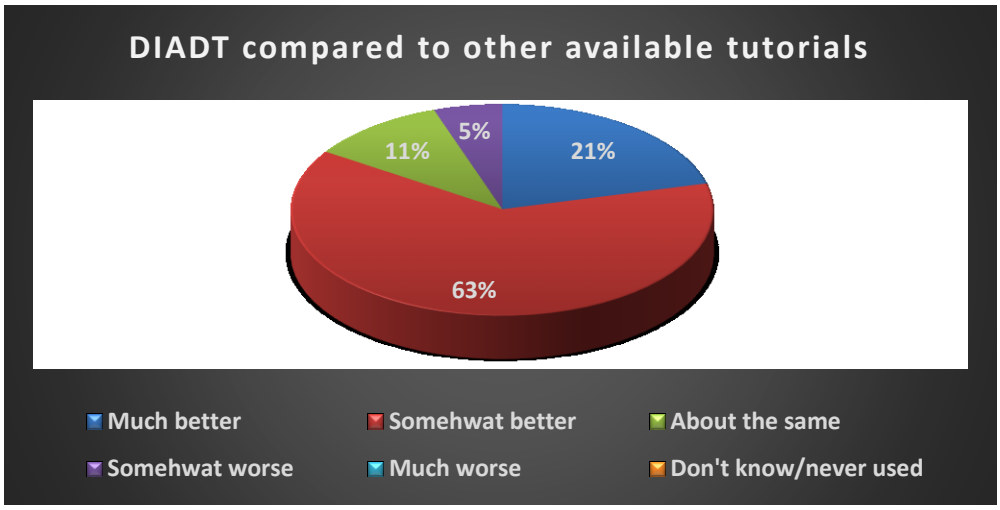

Figure 4.15. DIADT compared to other tutorials

From Figure 4.16: Likeliness to recommend this tutorial to others , we see that about 53% of the subjects are "Somewhat likely" and 37% of the subjects are "Very likely" to recommend this tutorial to others who may be in need to learn about UML activity diagram.

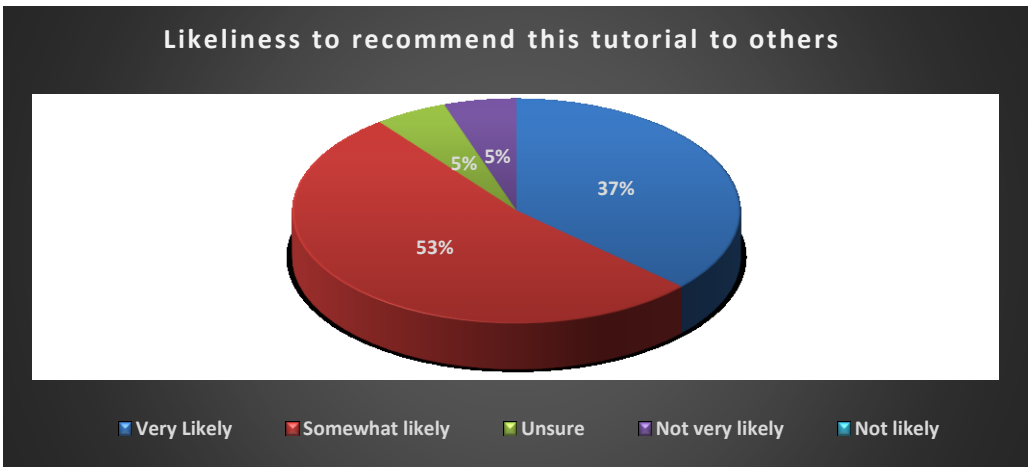

Figure 4.16. Likeliness to recommend this tutorial to others

From Figure 4.17: Overall experience in using this tutorial, we see that about 79%, a significant percentage of the subjects are "Somewhat satisfied" with their overall experience is using the DIADT tutorial. And 16% of the subjects, i.e. 3 out of 19 subjects are "Very satisfied" with their overall experience in using the DIADT tutorial and 1subject was "Not very satisfied" with their overall experience. From the suggestions that the subjects gave about the DIADT tutorial, the overall experience was affected by the need to installation of database and the application.

The survey questionnaire asked the subjects to complete a case study which required them to draw a UML Activity diagram for the activity "Renovate Home". This case study was conducted to be able to verify the ability of DIADT tutorial to be able to teach someone to draw a UML activity diagram in addition to the tests conducted throughout the tutorial that helped to test the theoretical knowledge gained by the subjects. From Figure 4.18: Case study completed, we see that about 74% of the subjects completed the case study. The UML Activity diagrams that the subjects completed are attached in the Appendix.

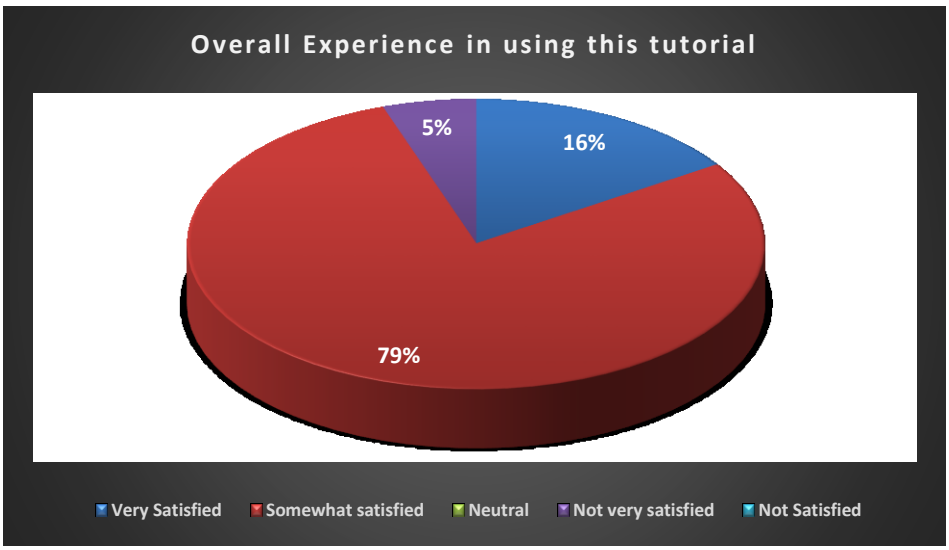

Figure 4.17. Overall experience in using this tutorial

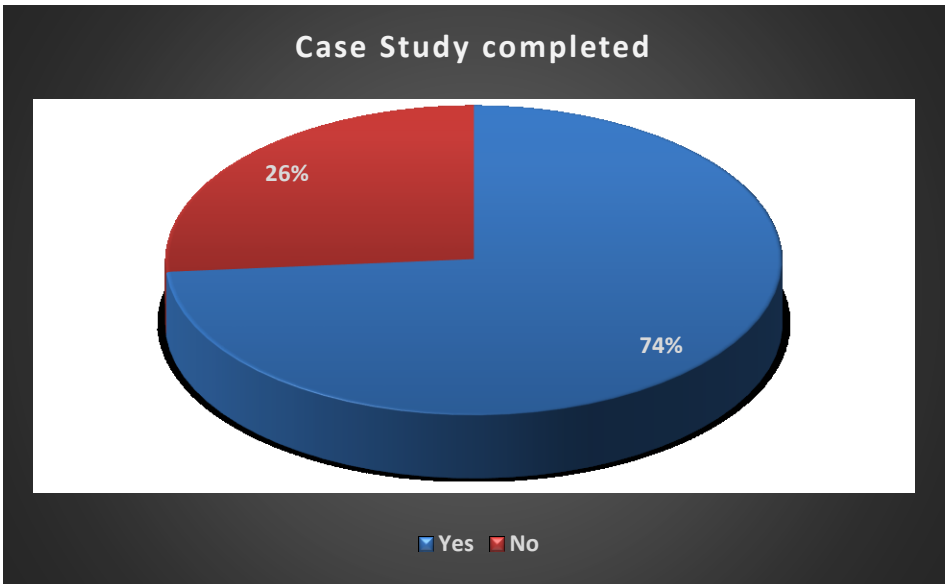

Figure 4.18. Case study completed

From the 74% of the subjects who completed the case study Activity diagram for the activity “Renovate Home”, we see from Figure 4.19: Other Resources used, 36% of the subjects used other resources after finishing the DIADT tutorial compared to the 64% who were able to

complete the case study purely by learning from DIADT tutorial and without using any other resources.

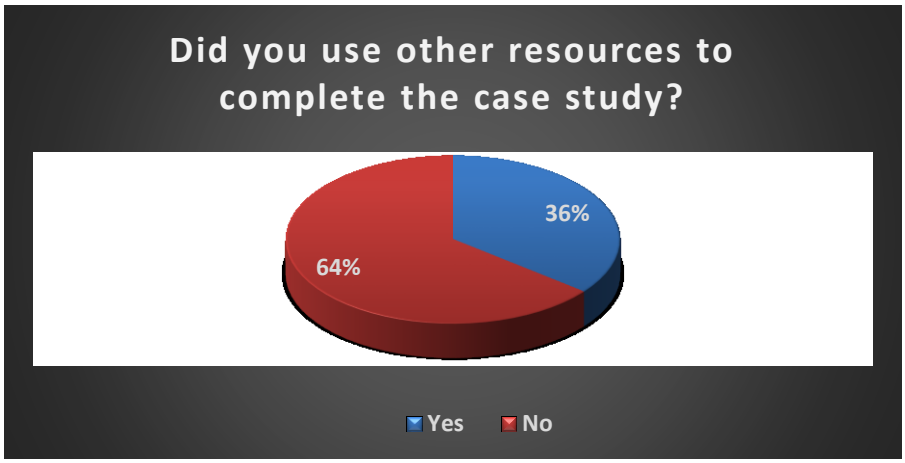

Figure 4.19. Other Resources Used

CHAPTER 5. CONCLUSIONS AND FUTURE WORK

5.1. Conclusions

In this paper, I have addressed the problems and the limitations of the existing Activity diagram tutorials mostly web tutorials. Some of the problems with the existing activity diagram tutorials is the lack of interactivity, lack of adequate information covering all topics with examples all at one place, broken links, distractions because of advertisements on web tutorials, some good tutorials especially video tutorials are accessible fully at a price. We have proposed a "Desktop Interactive Activity Diagram tutorial" application that will teach someone to draw an activity diagram and also addresses the problems with the existing tutorials. The effectiveness of the developed desktop tutorial application is evaluated and analyzed based on the survey conducted on 19 different subjects who were interested in learning to draw an Activity diagram. The subjects not only install and complete the tutorial but are also expected to complete a survey questionnaire that also includes a case study which required them to draw a UML Activity diagram for the activity "Renovate Home".

The survey results were analyzed using appropriate graphical analyzes and based on the overall survey results, the Desktop Interactive Activity Diagram tutorial application is very user friendly, interactive, simple, stimulated the interest of the subjects and has most of the information needed to teach someone to draw an activity diagram all at one place. The installation of the desktop tutorial application was a drawback in the learning process because of the time factor. Also, the desktop tutorial application is limited in its availability to a wider space of users who are in need of learning to draw an activity diagram. The Desktop Interactive Activity diagram tutorial application will more appropriate within local area network(LAN) like schools/universities,

business companies where the database can be installed in one machine and can be accessed by the entire network.

5.2. Recommendations for Future Work

1. We propose to add many other tutorials to the repository. Extensibility is one of the key features of this tool and its best used by adding more contents and more relevant topics to the collection. The key here is the ability to add more stuff without having to modify or rebuild the code base. The topics and the core contents is totally abstracted from the framework.

2. We propose to add the ability to connect to a centralized and remote database without having the need to install the DB at every user machine. This will be the ideal set up for a multi-user LAN environment. The ability to connect to a remote database is already present, but needs to be thoroughly tested in an actual local network with multiple concurrent users. This will greatly reduce the size of the distributable because distributable itself will be independent of the core contents of the database. This will also greatly simply the installation process which would require the users to download only one executable instead of two.

3. Finally we propose to convert this tutorial to a web based tutorial which can use the same .NET framework or take this to the next level by creating more interaction using action scripts for flash. By converting the existing .NET framework into web based tutorial, we can add different learning styles like auditory learning style.

CHAPTER 6. REFERENCES

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[20] http://www.nwlink.com/~donclark/hrd/Bloom/SOLO_taxonomy.html

APPENDIX A. SURVEY QUESTIONNAIRE

About you: Name

1. What is your highest level of education completed?

- ○ 2 year college degree
- ○ 4 year college degree
- ○ Professional degree
- ○ Doctoral degree
- ◉ Others (Please mention below)

2. What kind of relevant experience you have as of now or right now?

- ☐ Completed degree in computer science
- ☑ Pursuing a degee in computer science
- ☑ Others (Please mention below)

About Knowledge acquired:

	Poor	Below Average	Average	Above Average	Outstanding
3. How would you rate your knowledge on the topic "UML Activity diagram" before taking the tutorial?					
4. How would you rate your knowledge gained after taking the tutorial irrespective of your final score in the tutorial?					

About User Interaction:

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
5. Overall, this course has stimulated my interest in this subject.					

About Tutorial content:

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
6. The content is arranged in a clear, logical and orderly manner.					
7. The content explains the knowledge and concepts well					

8. The content is of appropriate length and difficulty.					
9. The examples shown are good.					
10. The tests were based on the contents covered.					

About Installation experience:

11. Clarity of installation steps.

- (•) Very Clear
- ( ) Somewhat clear
- ( ) Neutral
- ( ) Somewhat unclear
- ( ) Very unclear

12. Timeliness of application and database installation.

- ( ) Very time consuming
- ( ) Somewhat time consuming
- (•) Its okay

13. Your experience with the application installation.

- ( ) Very easy
- (•) Easy

○ Neutral

○ Hard

○ Very hard

About Application simplicity & Usefulness:

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
14. It was easy to use					
15. Application was simple					

About Overall experience:

16. How much would you like to take another tutorial on this framework?

○ Extremely likely

○ Very likely

◉ Somewhat likely

○ Unlikely

○ Not likely at all

17. Compared to other UML tutorials that you have used or is available, would you say that the DIADT application is:

○ Much better

- [ ] Somewhat better
- [ ] About the same
- [ ] Somwhat worse
- [ ] Much worse
- [x] Don't know or never used

18. How likely are you to recommend this tutorial to someone you know may be in need to learn about UML activity diagram?

- [ ] Very likely
- [x] Somewhat likely
- [ ] Unsure
- [ ] Not very likely
- [ ] Not likely

19. What is your overall experience in using this tutorial?

- [ ] Very satisfied
- [x] Somewhat satisfied
- [ ] Neutral
- [ ] Not very satisfied
- [ ] Not satisfied

20. Do you have any suggestions for improvement?

- Prefer a web based application
- Auto save would be nice
- Would be nice if DB installation was made easier like a single click.

21. **Case Study:** Construct an activity diagram for the following scenario:
Renovate home:

- Budget Planning
- Things to renovate
    - Paint the walls
    - Change the carpet
    - Buy furniture (new/used to fit the budget
    - etc.

22. Did you use online resources to complete the case study in question 21?

○ Yes

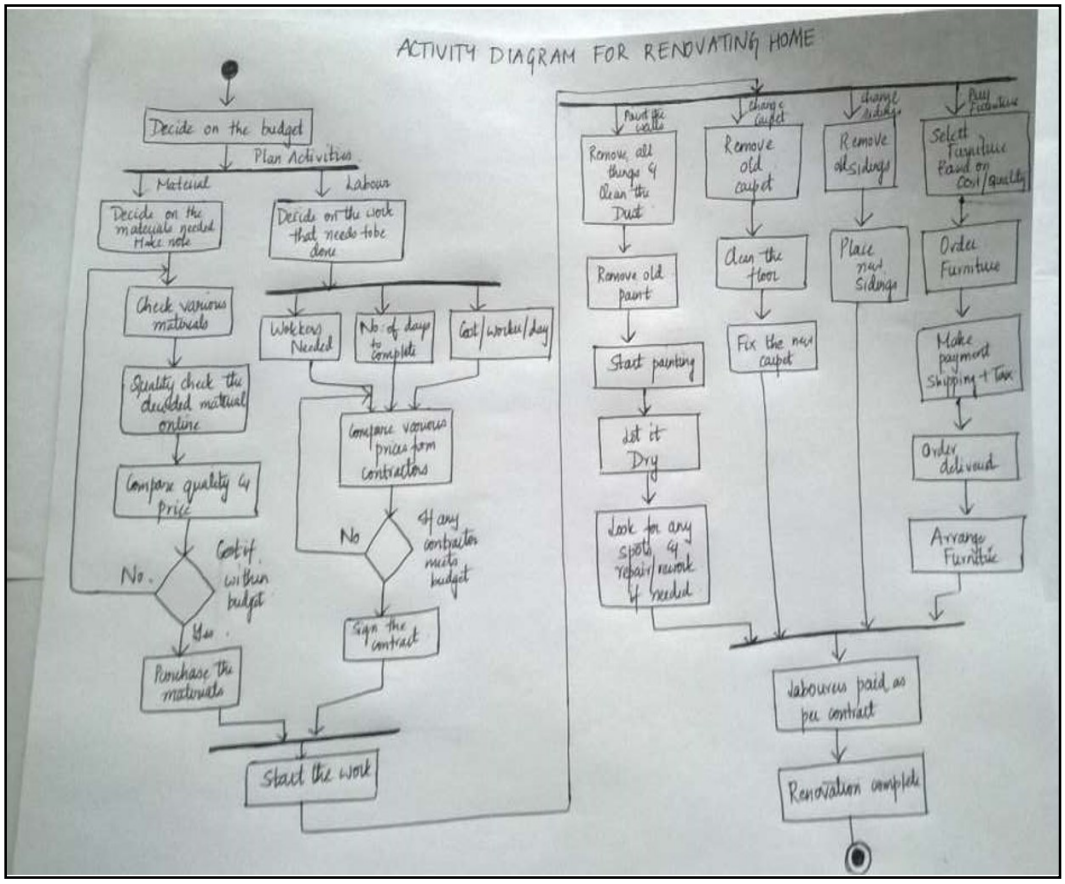
◉ No

If yes, approximately how much time did you spend online or other resources to complete the case study in question 21?

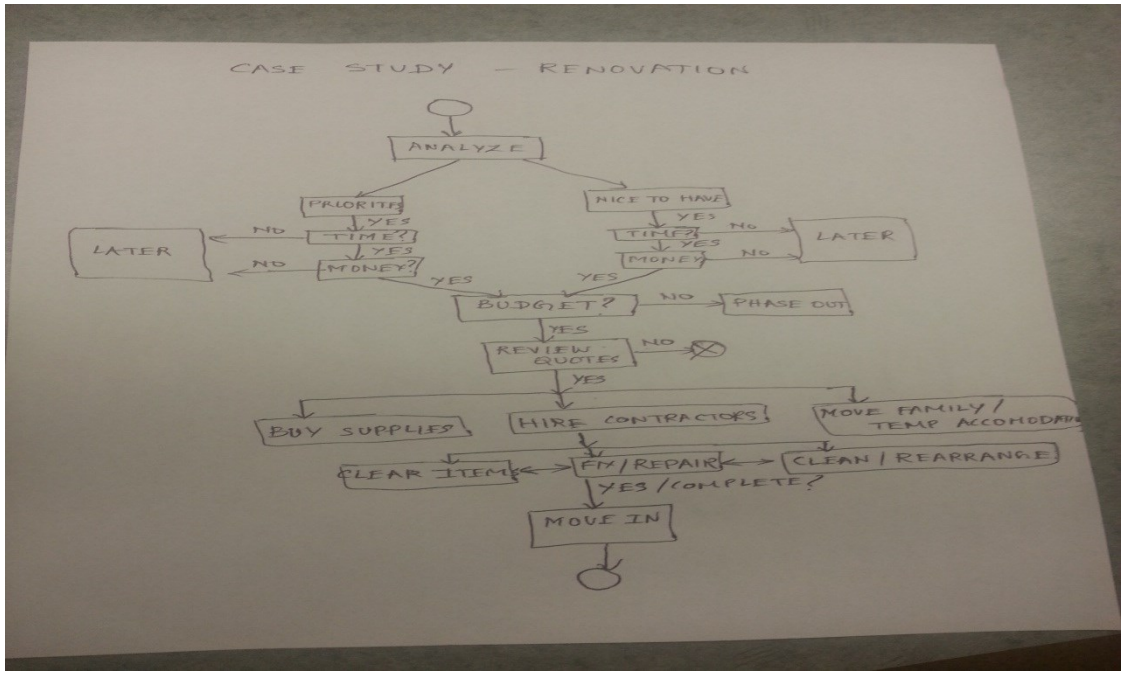
APPENDIX B. SUBJECT'S PROFILE

S.no	Highest Education	Relevant Experience	Currently a student?
1	Professional degree	Completed degree in CS	Yes
2	3 yr University degree	Completed degree in CS	Yes
3	4 yr degree	Working as Software Engineer	No
4	MS in CS	Working as Senior Market Data Developer	No
5	B.E in CS	Working as Computer Programmer	No
6	M.S in ME	Working as SAP Analyst	
7	B.E in CS	Worked in IT for 3 yrs.	No
8	Ph.D. in CS	Working as senior software Developer	No
9	B.E in CS	Working as Development Lead	No
10	M.S in CS	Working in IT	No
11	MS in CS	Working as Solution Architect	No
12	M.S in CS	Working in IT	No
13	Professional degree	Completed degree in C.S	No
14	M.S in CS	Completed degree in C.S/ Worked in IT	No
15	Professional degree	completed degree in C.S/ working in IT	No
16	M.S in SE	Working in IT	No
17	M.S in CS	Working in IT	Yes
18	B.E in CS	Working as Programmer	No
19	B.E in CS	Completed degree in CS	No

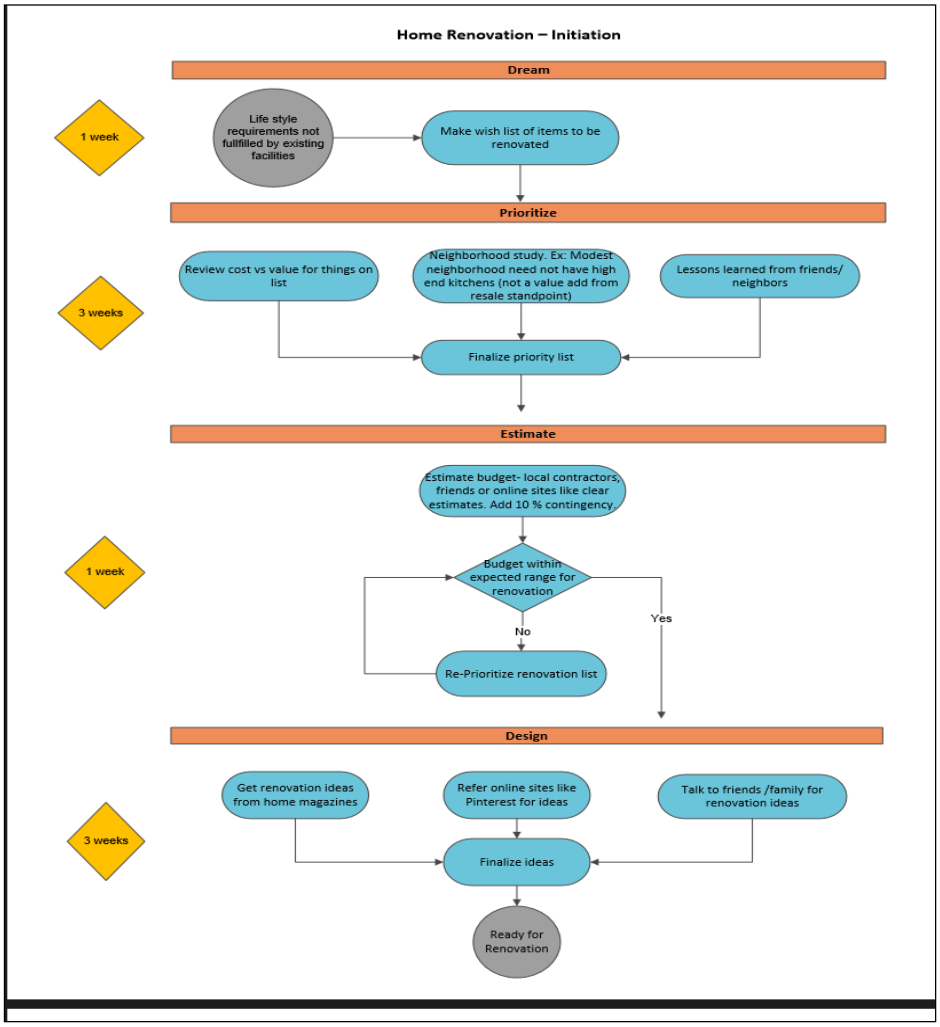
APPENDIX C. SUBJECT 1 CASE STUDY DIAGRAM FOR ACTIVITY: 'RENOVATE HOME'

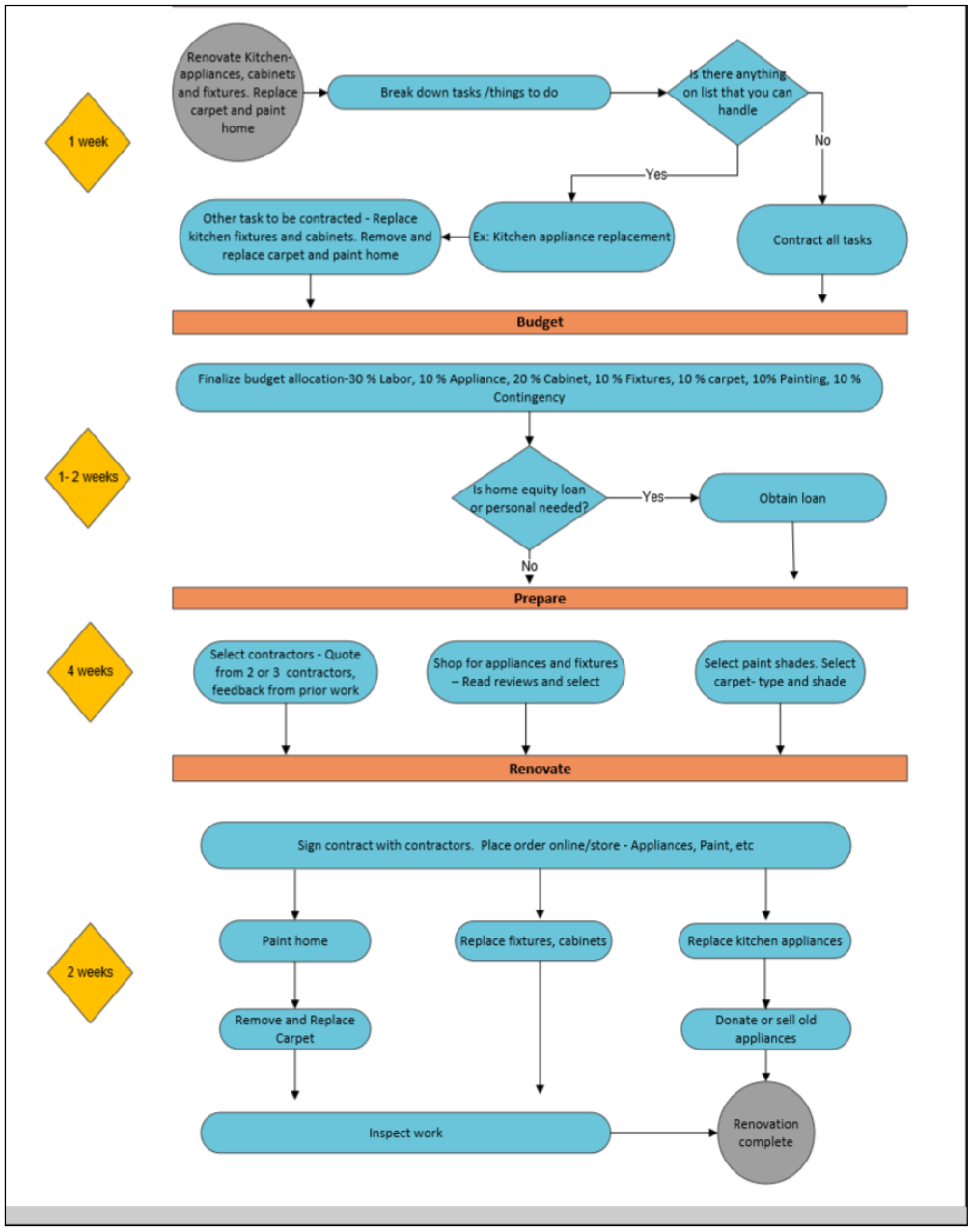


APPENDIX D. SUBJECT 2 CASE STUDY DIAGRAM FOR ACTIVITY: 'RENOVATE HOME'

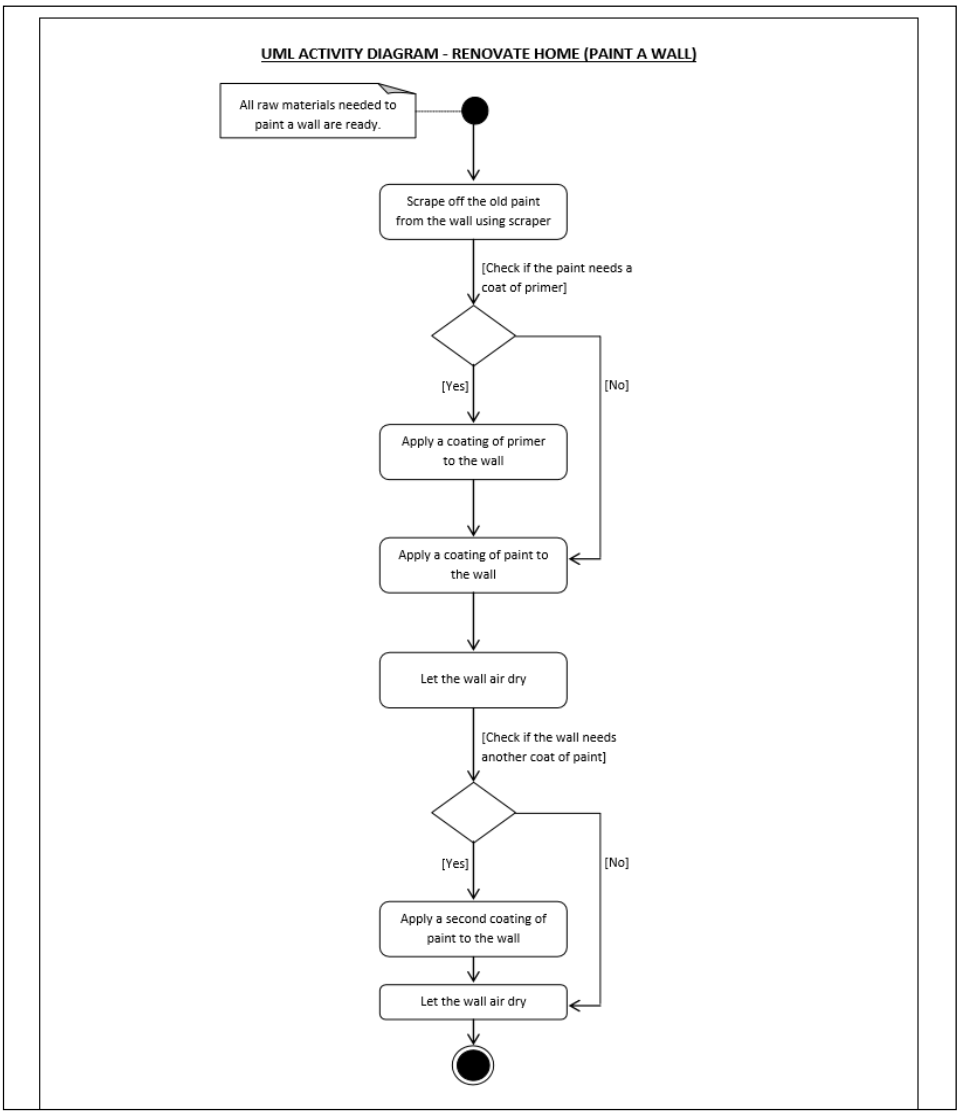


APPENDIX E. SUBJECT 3 CASE STUDY DIAGRAM FOR ACTIVITY: 'RENOVATE HOME'

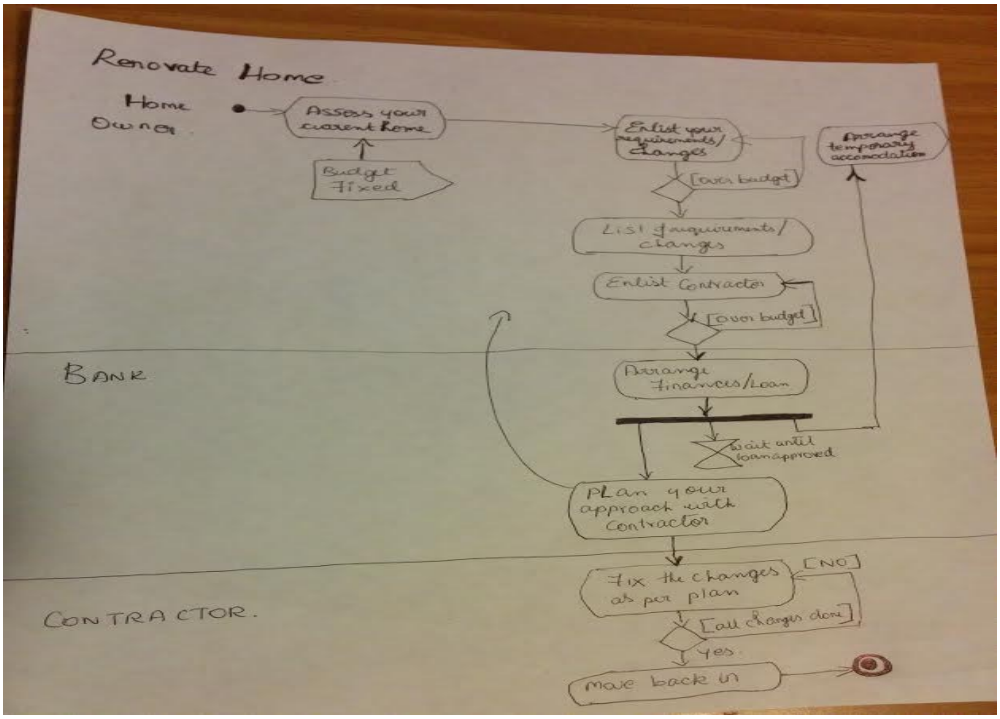



Renovate Kitchen- appliances, cabinets and fixtures. Replace carpet and paint home
Break down tasks /things to do
Is there anything on list that you can handle
No
Yes
1 week
Other task to be contracted - Replace kitchen fixtures and cabinets. Remove and replace carpet and paint home
Ex: Kitchen appliance replacement
Contract all tasks
Budget
Finalize budget allocation-30 % Labor, 10 % Appliance, 20 % Cabinet, 10 % Fixtures, 10 % carpet, 10% Painting, 10 % Contingency
1- 2 weeks
Is home equity loan or personal needed?
Yes
Obtain loan
No
Prepare
4 weeks
Select contractors - Quote from 2 or 3 contractors, feedback from prior work
Shop for appliances and fixtures – Read reviews and select
Select paint shades. Select carpet- type and shade
Renovate
Sign contract with contractors. Place order online/store - Appliances, Paint, etc
2 weeks
Paint home
Replace fixtures, cabinets
Replace kitchen appliances
Remove and Replace Carpet
Donate or sell old appliances
Inspect work
Renovation complete

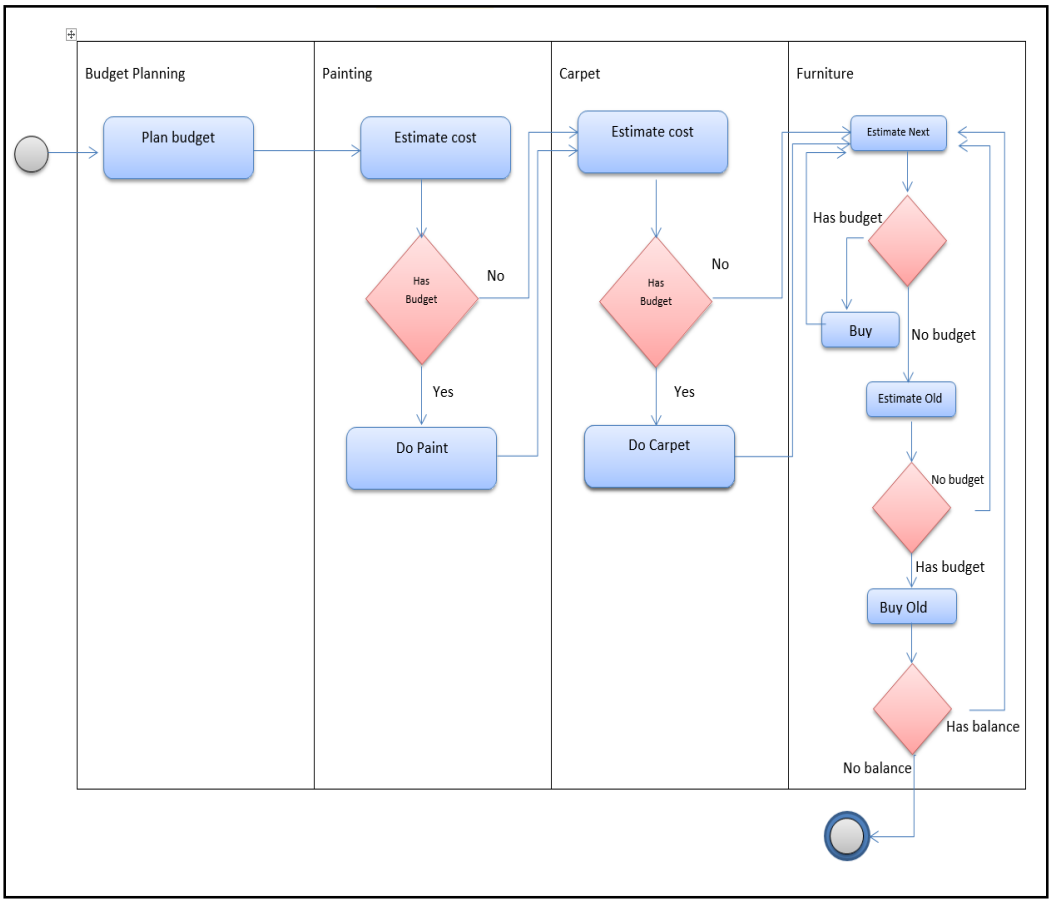
APPENDIX F. SUBJECT 4 CASE STUDY DIAGRAM FOR ACTIVITY: 'RENOVATE HOME'



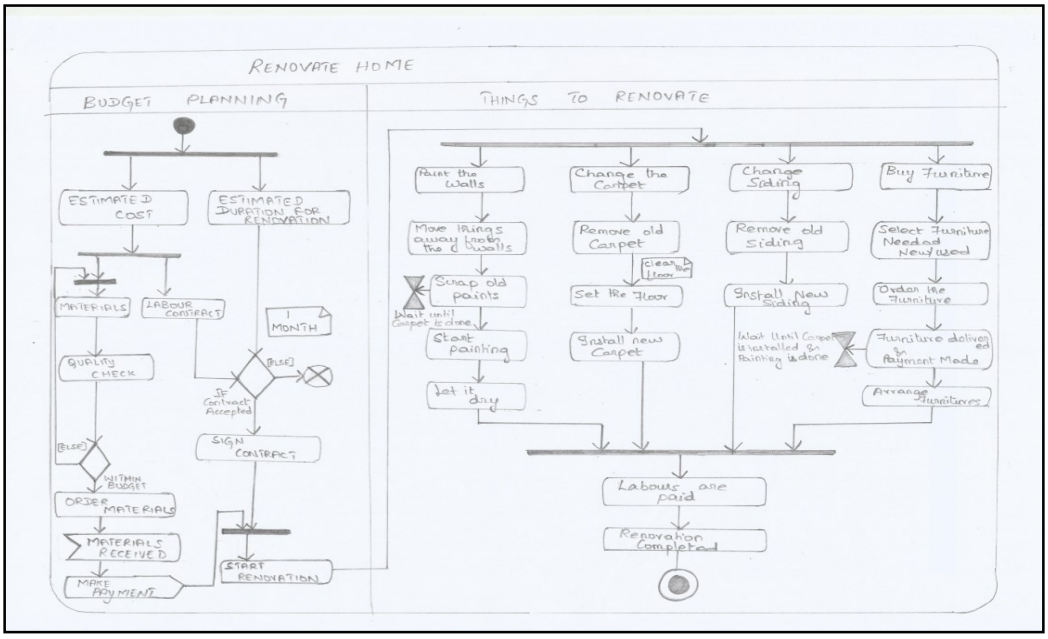
APPENDIX G. SUBJECT 5 CASE STUDY DIAGRAM FOR ACTIVITY: 'RENOVATE HOME'



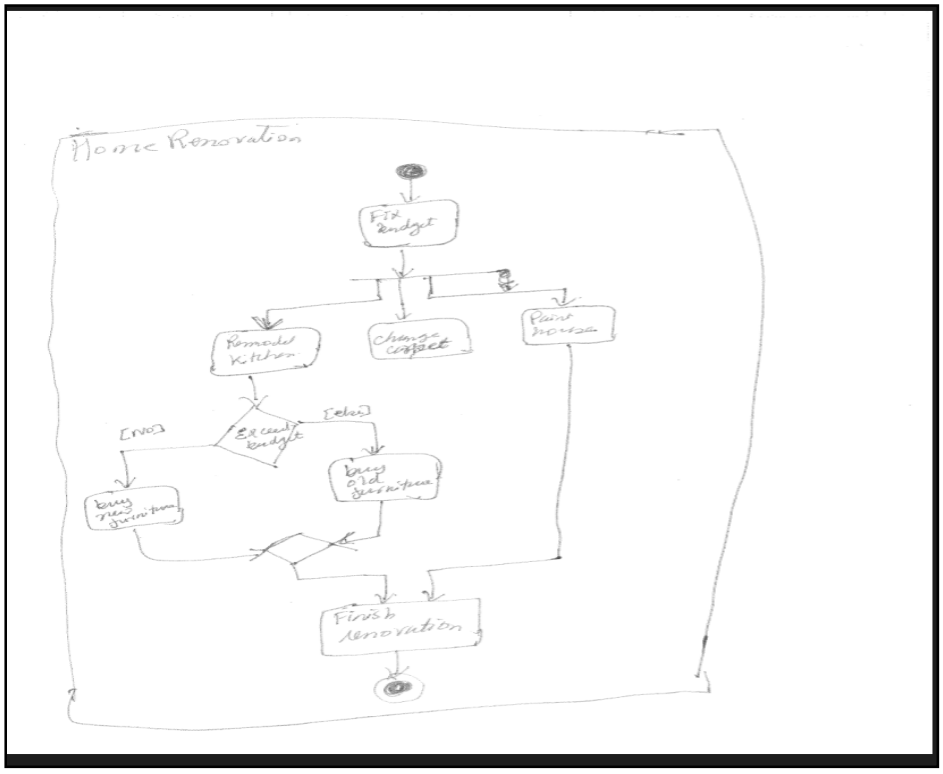
APPENDIX H. SUBJECT 6 CASE STUDY DIAGRAM FOR ACTIVITY: 'RENOVATE HOME'



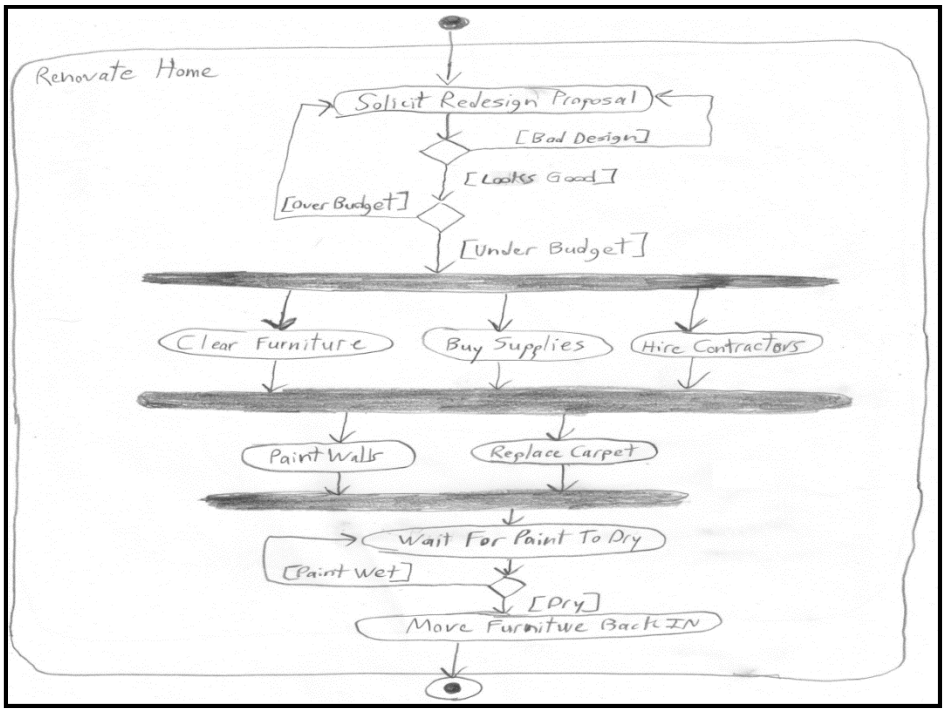
APPENDIX I. SUBJECT 7 CASE STUDY DIAGRAM FOR ACTIVITY: 'RENOVATE HOME'



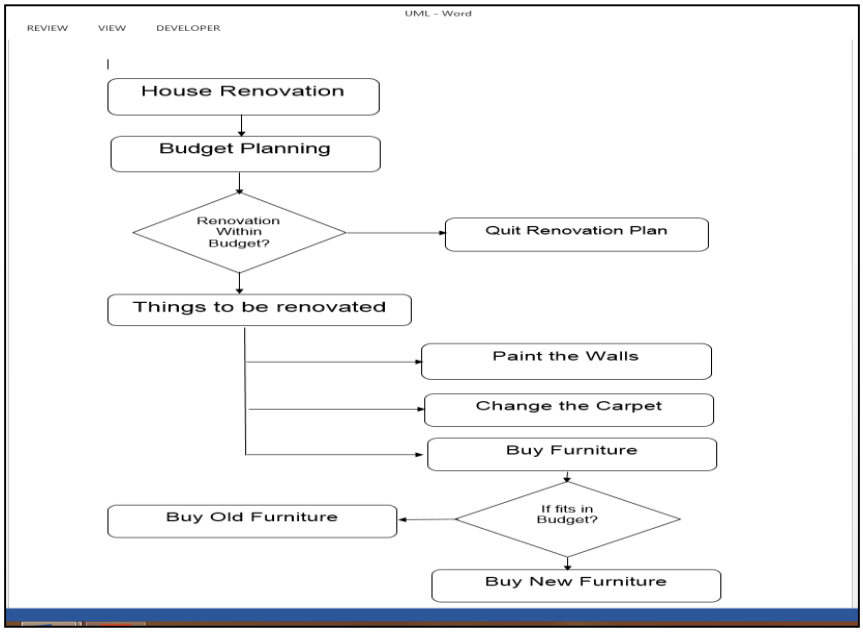
APPENDIX J. SUBJECT 8 CASE STUDY DIAGRAM FOR ACTIVITY: 'RENOVATE HOME'



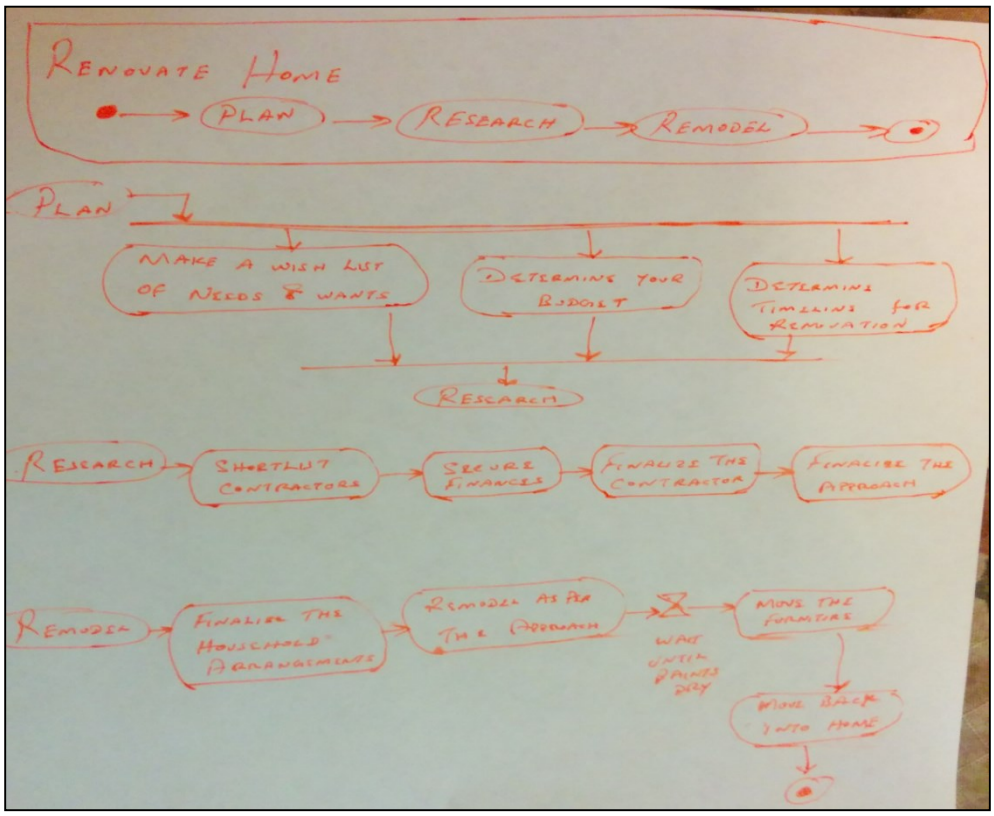
APPENDIX K. SUBJECT 9 CASE STUDY DIAGRAM FOR ACTIVITY: 'RENOVATE HOME'



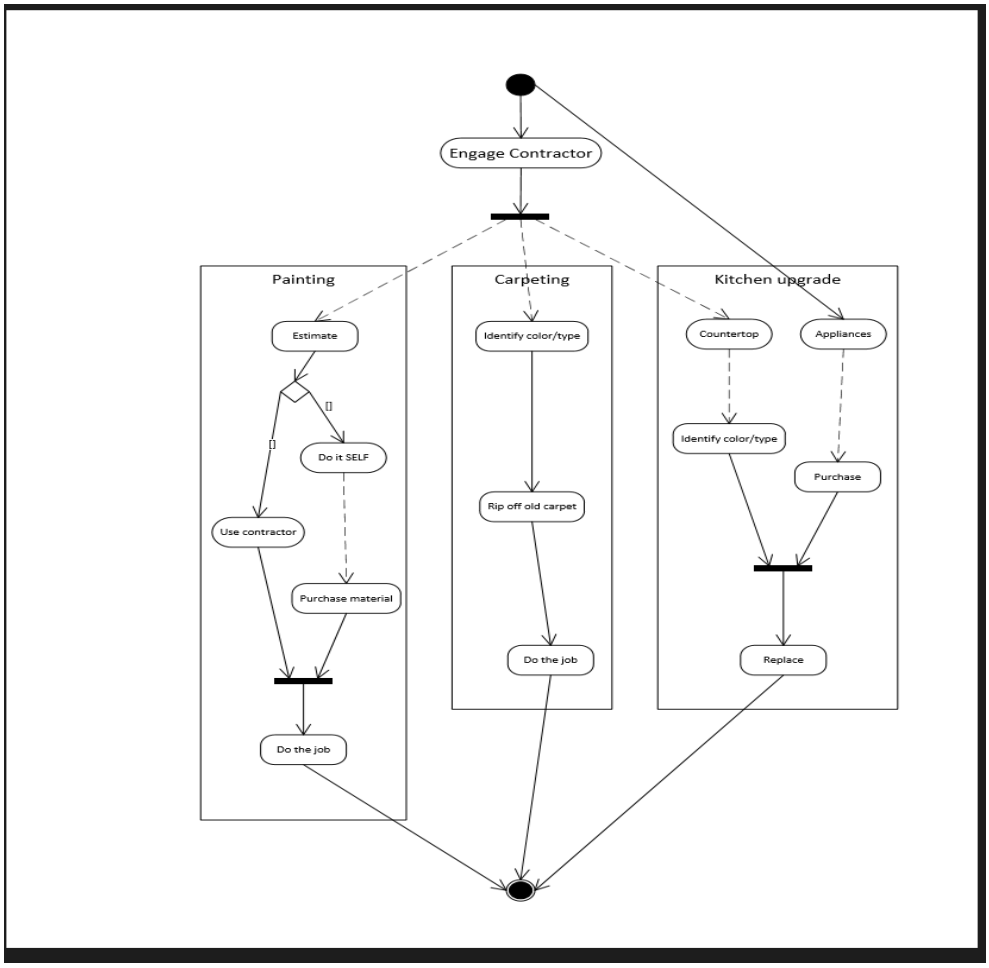
APPENDIX L. SUBJECT 10 CASE STUDY DIAGRAM FOR ACTIVITY: 'RENOVATE HOME'



APPENDIX M. SUBJECT 11 CASE STUDY DIAGRAM FOR ACTIVITY: 'RENOVATE HOME'



APPENDIX N. SUBJECT 12 CASE STUDY DIAGRAM FOR ACTIVITY: 'RENOVATE HOME'



APPENDIX O. SUBJECT 13 CASE STUDY DIAGRAM FOR ACTIVITY: 'RENOVATE HOME'