

# A Project Based Approach to Teach Object Oriented Modeling and Design Patterns

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**Abstract:** Object oriented techniques incorporate different software engineering techniques that can be used in development of all projects. Unified Modeling Language (UML) is a structured method which involves formal methodologies, and has made significant contribution in defining set of methodologies that can be applied to any software engineering effort. Our approach is to make students experience the real time application of Object Oriented Modeling and Design methods using supportive tools that help them to have a hands-on experience with the operational software design. This helps students to use emerging object oriented techniques to improve their knowledge on object oriented modeling and design, problem solving skills and team work skills that can be converted into useful computer applications.

**Keywords:** Object Oriented Modeling and Design, Unified Modeling Language, Software Engineering Techniques.

## 1. INTRODUCTION

The approach of using object - oriented techniques for designing a system is referred to as object oriented design. Object oriented development approaches are best suited to projects that use emerging object technologies to construct, manage, and assemble objects into useful computer applications[2]. Object oriented design is the continuation of object-oriented analysis, continuing to center the development focus on object modeling techniques.

Software development comprises different phases which include analysis, design, implementation, testing and deployment. Application development using traditional approach is a top down approach which uses data flow diagram, entity relationship diagrams etc. But object oriented approach is a bottom up approach and uses Unified Modeling Language constructs. Visual modeling of object oriented approach can be done using Rational Rose tool, which has the ability for reverse engineering and iterative development. By using this tool, different models used in object oriented approach can be

constructed and experimented. This helps better understanding of interaction between objects.

Recently object oriented approach of system development is being used widely in industries. This underlines the importance of object oriented approach and hence we decided to insist students to carry out their project using object oriented approach. This helps students to carry out their miniproject in effective manner by the knowledge that they have gained through the theoretical concepts of Object Oriented Modeling and Design (OOMD). This enhances students learning and to gain better technical knowledge. Mini projects help students to get an opportunity for detailed investigation skills on worthy topics, enables them to face challenging problems, to learn better from the experiences. Furthermore it is useful approach to orient student's interest and motivate them for better learning

## 2. RELATED WORK

Albert L. et al. [1] suggest that system analysis and design is a critical building block for Information System Education. It can be taught using the traditional approach or object oriented approach. This paper highlights different techniques, methods and tools used for developing new systems, which helps students to improve their analytical and problem solving skills. This paper also insist in data gathering techniques, fact finding and improving team work skills which are necessary skills for any system analysts. It also stresses teaching Object oriented modeling and Design in a better structure.

A good comparison between traditional approaches and object-oriented approach is elicited in [2]. Traditional approach has a lot of models such as waterfall, spiral, iterative and v-shaped, but all of them lack flexibility to deal with projects. Object-oriented development approaches are best suited to projects that use emerging object technologies to construct, manage, and assemble those objects into useful computer applications.

W. Al-Ahmad [3] discusses the use of design patterns during the transition phase from analysis to design of object-oriented systems. This paper introduces new design patterns that were discovered through the experience of teaching object-oriented analysis and design in both industry and academia. The patterns defined in [3] are low level design patterns that can be used in almost every application.

A survey is made on optimizations used in software design and architecture [4]. The techniques presented in optimizations of design, consisting of revising class design, maximizing inheritance, adding associations to optimize access paths, collapsing objects into attributes, delaying expensive computations, and caching the results of expensive computations. These techniques certainly improve efficiency in software design.

From the literature survey made it was evident that OOMD is being used in industry and academia. Hence it is an effective approach to implement projects.

### **3. SYSTEM DEVELOPMENT APPROACHES**

System development is a process of planning, creating, testing, and deploying an information system. The main approaches to system development are traditional approach and object oriented approach.

#### *Traditional approach*

The traditional approach to system development uses System Development Life Cycle (SDLC). It uses phases and activities, the activities of one phase must be completed before moving to the next phase. The structured approach looks at a system from a top-down view and it uses separate data and process models. The data flow diagrams are used to depict the business processes of a system, the information about the inputs, outputs, processes and data storage that needs to be designed and ultimately built. For data modeling, entity relationship diagrams are used.

#### *Object oriented approach*

Generally object oriented approach is data centric which involves entities attributes and processes, where entities encapsulate attributes and methods. Object oriented approach takes a bottom up approach to system development. It describes the real world objects of the application domain. Inter connected diagrams are used to represent views and functionality of a system. UML is a most common notation used in object oriented approach. The three are class model, state model, and interaction model.

Class model describes the static data aspect of the system [5]. Class diagram describes objects, their identity, attributes, associations and generalization. State model describes the temporal, behavioral control aspects of the system [5]. State diagram has to be written for

each class, where state, event, transition, will be represented. It shows the different states the object can take as the event occurs. Interaction model describes the collaboration of individual objects, the interaction aspects of the system [5], how an object interacts with other objects. It uses use case diagram, sequence diagram and activity diagram. Use case diagrams are used to describe a set of functions (use cases) that some system or systems (subject) should or can perform in collaboration with one or more external users of the system (actors). Each use case represents a piece of functionality that the system provides to its users. A sequence diagram shows the participant in the interaction that is objects and the sequence of messages over time among them. Activity diagram is basically a flow chart to represent the flow from one activity to another activity. The control flow is drawn from one operation to another. This flow can be sequential, branched or concurrent. Activity diagrams deal with all type of flow control by using different elements like fork, join etc.

System conception is a beginning of an application. Tentative requirements are formulated and outcome of this phase is the problem statement Analysis phase is to create models. Analyst must understand the problem and scrutinize the requirements by constructing the above mentioned models. It involves finding objects, organizing the objects, describing how the objects interact, and defining the behavior of the objects and internals of the objects. There are two sub phases of analysis: domain analysis and application analysis. Domain analysis is the process of identifying, collecting, organizing and representing the relevant information in a domain [1]. Application analysis addresses the computer aspects of the application that are visible to users.

The analysis phase determines what the implementation must do, and the system design phase determines how it is to be done.

During Design phase, a developer applies implementation constraints to the conceptual model produced in analysis phase. Such constraints could include the hardware and software platforms, the performance requirements, persistent storage and transaction and usability of the system. Important topics during design also include the design of software architectures by applying architectural patterns and design patterns with object-oriented design principles.

The purpose of class design is to complete the definitions of the classes and associations and choose algorithms for operations Class design involves realizing use cases with operations, formulating an algorithm for each operation , refactoring the model for a cleaner design, adjusting the class structure to increase inheritance and organizing classes and associations[5].

Design patterns are the important aspect of OOMD. Design pattern comprises three rules context, problem

and solution to the problem. Refinement of the subsystem and the relationship between the subsystems can be solved using pattern. Final stage is the implementation; it involves fine tuning classes and generalization, realizing associations.

#### 4. IMPLEMENTATION

The proposed idea of applying OOMD approach in project development was experimented for 5<sup>th</sup> semester students Master of Computer Applications (MCA). The students also have to carry out mini project in the same semester. Students were instructed to carry out mini projects using object oriented approach only so that they can implement and experience the concepts learnt in theory course *Object Oriented Modeling and Design Pattern*. In general students use the traditional approach to develop their project. Some students mix both the traditional approach and object oriented approach by writing class diagrams, sequence diagrams and use case diagrams which has few draw backs. Rational Rose an UML tool is being used to build class model, state model and interaction model. From conception phase to design they were made to use object oriented methodologies and few design patterns in their detailed design. In the beginning and during project development process students felt little difficult but at the end they were happy and enjoyed the process of learning.

The students were made to follow the steps depicted in the Fig 1. After the completion of each stage faculty reviewed the project and checks whether objects oriented approach is being carried out.

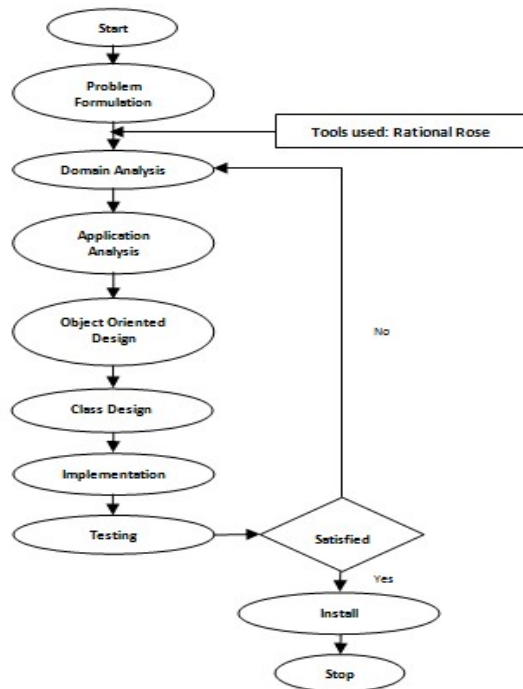


Fig 1: Execution structure

#### 5. ASSESSMENT AND RESULTS

Assessment is the important phase to measure the performance of students learning. This approach of doing project emphasizes on analysing, designing, implementing ability of the student. The project using object oriented modeling gives them a practical implementation of the knowledge gained in theory. This enriches their knowledge and confidence of developing other projects. This also increases creativity, communication skill, and better human relationships.

We have conducted a survey and given questionnaire of 5 likert-scale questions (based on 5 scale system: 1 being the least and 5 being the maximum), and questions were as follows.

Q1 – How much you enjoyed the Object Oriented Modeling and Design Pattern course?

Q2 – How well you understood the course better than if it had been lectured in the traditional way?

Q3 – How much you have undergone knowledge sharing in the project group?

Q4 – What level of practical knowledge you have gained from project based approach of teaching object oriented modelling and design patterns than in traditional method of teaching?

Q5 – How much confidence you gained for developing application using object oriented modeling and design approach?

Table 1: Student Feedback Survey

Question Number	Rating in a scale of 5 to 1				
	5	4	3	2	1
Q1	41	3	2	1	7
Q2	37	9	0	4	4
Q3	39	1	7	3	4
Q4	47	2	1	1	3
Q5	42	4	5	3	0

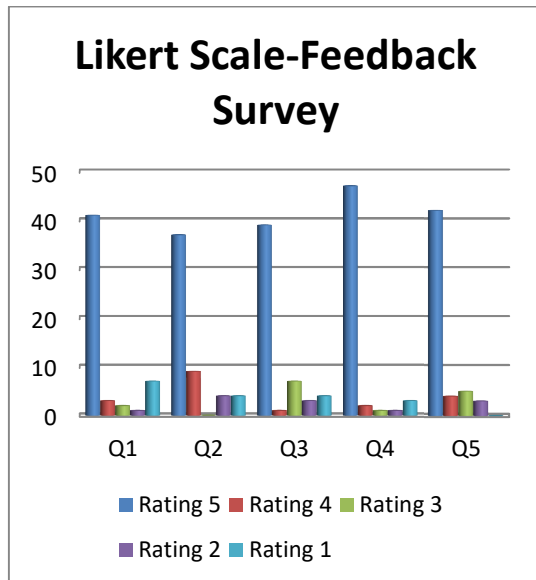


Fig. 2: Bar chart for Feedback Survey

From the Figure 2 it is evident that most students have gained practical knowledge and confidence to do a good project.

## 6. CONCLUSION

A practical approach of teaching object oriented modeling and design patterns course is presented. Students had a mini project course in the same semester, which they carried out using object oriented approach, so it was not a burden for them. We found that students find it very interesting and sometimes difficult also. They gained practical knowledge of object oriented approach as well as confidence of doing a project. Our approach towards making students experience about the real time application of OOMD methods using supportive tools helped them to have a hands-on experience. They also gained problem solving skills, team work skills and communication skills. The quality of mini projects has been improved. In coming years we would like to implement different design patterns which will further helps in improving project quality.

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