Project Based Learning – Computer Graphics

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***Abstract*—In computer graphics course the visualization of information is an important aspect. Considering the outcome based education system, we have introduced the concept of project based learning. Here the student has the freedom to visualize solutions to problems of different domains. This paper presents a project based approach where in the theoretical concepts of graphics are applied to real-world problems. The skills acquired through this project based learning are those desired by today's employers. It empowers students, makes them active learners working effectively in a team and creatively applying what they have learnt to life-long endeavors.**

Keywords—Project based learning; Computer graphics;

I. INTRODUCTION

In outcome based education system the primary goal is to enhance learning outcome of students. The traditional educational system was an input-based education whereas the modern system emphasizes result-oriented thinking. Knowledge is assimilation of information after learning and skill is the ability to apply the knowledge. Introducing projects in the curriculum will emphasize learning attributes that are long-term and students centered.

Projects can increase student interest because they involve students in solving authentic problems, in working with others, and in building real solutions. Projects have the potential to enhance deep understanding because students need to acquire and apply information, concepts and principles and they have the potential to improve competence in thinking because students need to formulate plans, track progress and evaluate solutions [2].

Changes in engineering education were inspired by employers who indicated a need for engineers who are not only experts in their domain, but who are also adept communicators, good team members, and lifelong learners [6,7].

In brief, available research suggests that project based courses improve retention, student satisfaction, diversity, student learning, collaborative and organizational skills [1]. The students also acknowledge that the project-based practical assignments help them to better understand the concepts explained in lectures [5].

II. DESCRIPTION OF COURSEWORK

Computer graphics is used in diverse applications from the visualization of complex scientific data to the special effects in movies and the animated characters in computer games. Computer Graphics is a course which we teach as part of our under graduate program. The objective of this course is to introduce the programming principles of computer graphics including fundamental data-structures and algorithms. Open GL is an open source graphics tool consisting of library of functions for modeling and rendering. Along with the theoretical concepts of graphics the Open GL tool is taught for implementation of the concepts.

The course was integrated with the laboratory component. The lab problem set mainly comprised of implementation of theoretical concepts such as transformation, rasterization, clipping, device interactions, three dimensional modeling, etc.

TABLE I. OLD COURSE OUTCOMES

Sl. No.	Old course Outcomes
1.	**Differentiate the imaging concepts of physical systems and Graphics.**
2.	**Implement the input device event handling using OpenGL.**
3.	**Recognize the different transformations required in animation and implement them.**
4.	**Implementation of different viewing conditions using OpenGL.**

Through this exercise we found that the students had gained a good understanding of Open GL tool and imaging concepts of graphics. As these theories were executed independent of each other, the students lacked the ability to integrate. We found that the course was content driven and lacked integration of the concepts studied. The basic ability of an engineering graduate is to design a complete solution to a problem which is the industrial requirement for his employability. To achieve ABET specified graduate attributes we incorporated aspect of project based learning.

III. PROJECT BASED METHODOLOGY

The project based learning is one of the variants of self-organized learning which involves activity oriented group work. This form of learning focuses on project in which student team work on a concrete task. This learning enables student teams to discuss, collect, collate and contribute their own abilities [4]. The traditional class room teaching is short, isolated and teacher centered whereas project based learning emphasizes learning activities that are long term, inter disciplinary and student centric. Project work is recognized as having many educational and social benefits in particular providing students with opportunities for active learning [3].

The course outcomes shown in Table I that were set for the course were not mapping to many of the graduate attributes. To overcome this we reframed the course outcome number 4, as shown in Table II, by introducing a team project as part of the course.

TABLE II. NEW COURSE OUTCOMES

Sl. No.	Old course Outcomes
1.	**Differentiate the imaging concepts of physical systems and Graphics.**
2.	**Implement the input device event handling using OpenGL.**
3.	**Recognize the different transformations required in animation and implement them.**
4.	**Implement simple graphics projects with different viewing conditions and lighting and shading effects using OpenGL.**

Students were free to pick a team mate and choose projects based on their interests. The project ideas emerged from the needs in the community which arise from social issues, educational and recreational needs. The projects chosen by the students established the connection between class room teaching and real life problems. A list of few of the projects that were implemented by our students is listed in Table III.

TABLE III. SAMPLE PROJECTS

Sl. No	Title of the Project	Concepts	Application
1.	**Tower of Hanoi**	**3 D modeling, Tranformations, Input device interaction, Shading,Lighting**	**Data Structures**
2.	**Nearest Neighbour Classifier**	**Interaction, Tranformations**	**Data Mining**
3.	**Process scheduler**	**Tranformations, Input device interaction,**	**Operating Systems**
4.	**Brownian Motion**	**Tranformations, Input device interaction, Lighting**	**Particle motion**
5.	**Queues and Stacks**	**Tranformations, Input device interaction**	**Data Structures**
6.	**Graphics editor**	**3 D modeling, Tranformations, Input device interaction, Shading,Lighting**	**System Software**
7.	**Water cycle**	**Tranformations, Input device interaction**	**Geography**
8.	**Minesweeper, Tic-tac-toe,Tetris**	**3 D modeling, Tranformations, Input device interaction, Shading,Lighting**	**Entertainment(Games)**

Once the problem was defined students performed a thorough literature survey and formulated an approach to implement the solution. We observed that the projects such as nearest neighbor classifier, Brownian motion visualization were not part of their curriculum. This shows project based learning facilitates students to integrate the contents of different domains as required by the application.

The team members of the project implemented their ideas using Open GL tool. Some of the concepts such as data structures, operating systems were already introduced to the students in their previous semesters. By doing the projects in these topics students gained a thorough understanding of the conventional class room teaching. The water cycle project was to demonstrate the process of water cycle for primary school children. This requirement which emerged for a societal need where in the students took a great care to make it educative and interesting for children. The students who developed the graphics editor expressed little difficulties due to implementation issues. This experience made them appreciative of the existing editors they use. They could add most of the features available in the commercial editors through their perseverance. The gaming projects arose for recreational needs. Although some games were modest others were based on complex techniques of artificial intelligence.

Next a technical report had to be submitted about the project. The report writing enables to consolidate the information and communicate the details of their work .Finally the demonstration and presentation had to be made enhancing their communication skills.

IV. CONCLUSION

The project based learning technique applied to computer graphics course facilitated the students to learn by designing and building solutions to real world problems of their interest. It is a very effective and engaging way of students to learn computer graphics. The students expressed the development of perseverance, shared responsibility in the team, relevance of the course as applied to real life issues. Some of these qualities cannot be taught in classroom, but can only be imbibed through project based learning. The skills acquired through this project based learning are those desired by today's employers. It

empowers students, makes them active learners working effectively in a team and creatively applying what they have learnt to life-long endeavors.

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