A Student Team Research Project Approach To The Second Course In Computer Graphics

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Abstract

This paper describes an approach to teaching the second course in computer graphics using student teams to do research on a graphics API of their choosing. Students are required to give seminars to the rest of the class on the API they researched, implement a significant software project using the API, and write a report on the API. Experience shows the students choose a variety of APIs to research. The students enjoy the approach to the course, and feel they learn a lot using this approach.

Keywords

Computer graphics, graphics API, team research, team project

1. INTRODUCTION

One of the problems computer graphics educators face is which graphics API, if any, to use in their courses. Over the many years that I have taught computer graphics I have taken a couple of approaches. In the beginning I had the students write their own graphics library, providing them only set pixel and read pixel routines. A few years ago I switched to using OpenGL in the first course, when it appeared OpenGL was becoming an adopted industry standard, computer graphics textbooks using OpenGL appeared on the market, and the API libraries were readily available. Although my students pick up OpenGL easily and appreciate what it can do, it is clear from comments that some of them make that they wished we had studied some other graphics API. This paper describes an approach I have recently taken to allow students to pursue their graphics API interest in the second computer graphics course at Rose-Hulman Institute of Technology.

Students interested in computer graphics begin by taking CS 351, Computer Graphics. This is a traditional first course in the subject matter, covering two-dimensional and three-dimensional graphics in OpenGL. The course is one quarter (ten weeks) in duration. Students learn about graphics systems and architectures, event-driven programming, coordinate systems, transformations, color models, projections, shading and lighting, hidden surface removal, curve and surface modeling, and implementation details. The book by Ed Angel [Angel00] is used as the text for the course. Students who successfully complete this course are well prepared for further study in computer graphics.

2. THE SECOND COMPUTER GRAPHICS COURSE

Many students do decide to continue with the second computer graphics course, CS 451, Advanced Computer Graphics. Like the first course, this course is one quarter long. The first three or four weeks of the course are spent covering topics from Angel's [Angel00] text that were not covered in the first course. Topics covered include ray tracing, texture and bump mapping, and an introduction to fractals and visualization. For the remainder of the term, students are immersed in a research project that has them investigating a different graphics API (from OpenGL) of interest to them.

Before students begin the project, I organize them into teams of three or four students. Each student can indicate the names of other students in the class that he or she would prefer to work with on the research. In addition, each student is asked to rank his or her preference of which graphics API he or she would prefer to research. I give them several well-known ones (e.g., Pixar's RenderMan, Java3D, DirectX, Microsoft Foundation Classes, VRML). Students can also indicate other graphics APIs they know about that I have not listed. Based upon each student's

teammate and graphics API preferences, I decide the composition of each team.

The research project has three deliverables from each team. First, one or two seminars on the graphics API the team researched. These seminars are presented to the class during the regular class meeting time. The number of seminars each team has to give depends on the number of teams researching a particular API. Two days are devoted to each API, so if only one team is researching it, they have to present all the material over the two days. If two (or more) teams are researching a particular graphics API, they have to meet to coordinate the presentation of material.

The second deliverable is a written research report on the graphics API. In the report students are asked to discuss the strengths and weaknesses of the graphics API they researched, give some tutorial information on how to use the graphics API (along with some example code and images), and compare the graphics API to OpenGL.

The last deliverable is a software product, using the graphics API researched, to generate a graphics image, interactive application, or animation. The theme of the produced software is up to each team; I set no restrictions on this aspect. Students are told, however, that the software they write must demonstrate a significant set of the features of the graphics API they investigated. If the graphics API being researched is not available on campus, some funds are available to acquire an appropriate license (if needed) for the graphics API and install it on one or more appropriate computers in the school.

Students undertaking this research project may be doing something of this magnitude in teams for the first time, especially in the area of team report writing. To give them some advice and guidance, a colleague in our school's Humanities and Social Sciences department assisted me in preparing some lecture material on collaboration strategies and designing and writing a team report. This colleague teaches our school's Technical Communications course, and thus has expertise in this area.

Once the research project is assigned and the students have been given all the upfront material they need, I cancel formal class meetings for three weeks to give them ample time to do the research. Students are told that they are each expected to spend about eight to twelve hours per week on the project (this includes the class time they are being relieved from, as well as expected homework time). They are also told that I am available for consultation and questions, either in person in my office, by phone, or by e-mail. The class meets again formally for the last three weeks of the term. During the eighth and ninth weeks (of a ten-week quarter) students are presenting their seminars. In the tenth week formal presentations of their software products are given.

3. EXPERIENCES

Overall, my students and I are all very pleased with the way the course is handled and with the learning experiences had. As a result of the research, each student has been exposed to a second graphics API in great detail (the first API being OpenGL from the first course). Moreover, all the students have been exposed to several additional graphics APIs from the seminars and project presentations their peers gave at the end of the course.

During the winter term of this academic year, I had ten student teams in two sections of the Advanced Computer Graphics course. Four teams (two in each section) investigated RenderMan, three teams (one in one section and two in the other) investigated DirectX, two teams (both in the same section) investigated Java3D, and one team investigated VRML. Students produced a myriad of projects using these graphics API, including:

- A movie showing a typical desk, with a five-ball pendulum toy where the two end balls swing back and forth. The balls change shades as time moves on.
- A movie showing dominoes set up to fall in a chain reaction, and then having them fall.
- A screensaver that models the image from the movie *The Matrix*.
- A VRML world of a castle with three buildings in the courtyard, each building having a different game (chess, checkers, backgammon) inside it.
- A program that has a disco setting for a set of dominoes that topple over, complete with colored, rotating lights.
- Games - 3-D tic-tac-toe, Pong, and 3-D Tetris.

At the end of the term, in addition to the standard course evaluations that students fill out, I had the students complete an evaluation of the team experience. One set of questions I asked them was "Was the research and project worthwhile? What did you learn from doing it? Is this approach a good thing to do for this course?" It was clear from the students' responses to this set of questions that this was a great approach to the course. Some comments students provided stated:

- "I loved the project. Our team worked hard all the off days. As long as the teams got going like ours it is a wonderful idea."
- "The research and project were worthwhile. I learned a lot about VRML as well as effective communication skills in a group project. This is a good approach for the course."
- "The research and project were very worthwhile and I learned a lot of interesting and useful information. I liked having the opportunity to research an interesting topic for an extended period of time."
- "This was a great way to learn the new APIs. I loved working with RenderMan, and learning what it really is. Thank you!"
- "I learned a great deal about RenderMan and also I was given a new approach to thinking about graphics."
- "Very worthwhile. I am a very hands on learner. I understand the transform matrices several times better now that I've implemented classes that fully utilize them."
- "It was great to be able to learn about RenderMan because of all the computer-animated movies that have been coming out. I also liked being able to hear the basic information about other graphics languages. Good approach."

Several students also suggested I change the order in which the deliverables are due. I had the seminars due first, the written report due second, and the computer project due third. These students thought that the computer project should be due first, as they learned some things, and had some things clarified, in completing the project that they wished they knew for the seminars and reports. I will give this some consideration for the next time I teach the course.

4. CONCLUSION

This paper has described a student team research project approach to teaching the second computer graphics course. Students are responsible for researching a new graphics API from one they already know. Each team presents one or two seminars on the graphics API, writes a research report, and implements a computer project using the researched graphics API. The course is well received by students, and they are able to grasp new graphics APIs easily and quickly due to the foundation they received in the first graphics course, where OpenGL was used. I am confident I will continue to use this approach in teaching this course.

5. REFERENCES

[Angel00] Angel, Edward. *Interactive Computer Graphics: A Top-Down Approach with OpenGL (Second Edition)*. Addison-Wesley, 2000.