How An Independent Studies Project Can Help Prepare Students For Graduate School

Marc Beck, Murray State University, Murray, Kentucky USA

ABSTRACT

This paper describes a directed research course in which a group of senior level college students conducted a research project and documented their findings. The goal of this project was to better prepare undergraduate students who are planning to continue their education in graduate school. This project resulted in a professional survey paper and helped the students develop valuable research, writing, and presentation skills. A group of selected students was tasked with analyzing and comparing different 3d file formats and 3d graphic programs and summarized their findings in a survey paper. As part of the project the students developed an algorithm that ranked the different items by taking into account factors, including cost, user friendliness, and compatibility.

Keywords: student career success, Higher Education, student driven research

INTRODUCTION

In 2013, the likelihood for Computer Science majors to obtain a graduate degree was 33.3%, which was slightly below the average for all majors combined at 35.1% (US Census Bureau, 2013). According to the Council of Graduate Schools (Council of Graduate Schools, 2013), 40% of graduate students in STEM fields complete their Master's degree within two years and a total of 66% complete it within four years. That leaves 34%, who either take even longer to complete their degree or drop out. With 43%, doctoral programs have the highest dropout rates of all post-baccalaureate programs (Ampaw and Jaeger, 2012). These dropout rates and the amount of extra time it takes some of the students who do graduate suggest that many graduate students are struggling. Many graduate students are overwhelmed with their research assignments (Oswalt and Riddock, 2007) and are not used to the different structure compared to their undergraduate coursework. For example, in graduate school, understanding the course material is far more important than memorizing it (Chang, et al., 2007). Graduate students often take longer than initially expected to complete their degree. Many of them even abandon their pursuit of a graduate degree altogether (Council of Graduate Schools, 2013). The amount of time it takes for students to decide to drop out varies from student to student.

BACKGROUND

The Department of Computer Science and Information Systems (CSIS) at Murray State University (MSU) has about 250 students. About 115 of them are undergraduate students majoring in Computer Science (CSC), the rest are undergraduate and graduate students in the Computer Information Systems (CIS) and Telecommunication Systems Management (TSM) programs.

Graduate students are expected to do research, perform experiments, present projects, and publish papers. Pabst (Pabst, 2011) describes universities as places that simultaneously create and fulfill a demand for knowledge. This is accomplished through research. Solving old questions often raises new ones, which then themselves require solving. Graduate students, especially in the Doctoral Program are at the forefront of this process and are required to develop the skills to acquire, generate, possess, interpret, and discuss knowledge (Pabst, 2011). An important skill in graduate school, especially when pursuing a terminal degree, is therefore the ability to write research papers. Students majoring in computer science usually take courses in composition offered by the English department during their freshman year and later have very few opportunities to write extensively, particularly on topics in computing (Kay, 1998). This project does not only address writing, but also oral presentation skills.

Several factors that contribute to the high dropout rates among graduate students have been found. According to Carpenter et al. (Carpenter, et al.), one reason that many students are ill-prepared for the graduate school application process or for the graduate school experience, is if their undergraduate institution has only undergraduate programs.

That means that students often do not know what is expected of them in graduate school, since they are not interacting with anyone who is going through that experience. Hall et al. (Hall et al., 2017) state that undergraduate GPA and GRE score are unreliable as predictors for success in graduate school because they do not measure the student's ability to conduct research.

PREVIOUS RESEARCH

There have been numerous attempts at better preparing students for life after college. Carpenter and Colleagues began offering seminars (Carpenter, et al.) on why or why not to pursue a graduate degree and what to expect in graduate school. For those students who do not move on to go to graduate school, most enter the workforce and some even try to start their own business. Solutions have been developed to prepare those students for their future career as well. Pilskans (Pilskalns, 2009), for example, developed a senior project with the goal to teach students entrepreneurial skills that would help them succeed in commercializing their ideas.

The author attempted a similar approach, however this approach was aimed at preparing undergraduate students for graduate school instead. In order accomplish that, a research project was offered as an elective special topics course to a selected group of four undergraduate students, all of which were seniors at the time.
As a topic for their project, the students were given the task to address the following problem: A large number of different file formats for 3d graphic objects are available. Most 3d editing and rendering software and game engines only support certain formats and not others. Third party conversion tools exist, but often cause data loss when converting one file format into another. The large number of different file formats and programs to deal with them can be confusing. It may often be difficult to choose one of the many different file formats for a specific project. The task given to the students was to compare and evaluate the most common of the many file formats and to rank them based on a number of different criteria to find the most relevant ones.

In order to find a solution for this problem, the group was given the task to examine the most common file formats and the most common 3d graphic programs and to write a survey paper which they would present at a conference. The students had been given a great deal of autonomy by the instructor and they were very creative in developing a method to rate the different programs and file formats.
A paper describing a similar project to evaluate 3d file formats and software was published by McHenry and Bajcsy in 2008 (McHenry and Bajcsy, 2008). That paper is now partially outdated, since new 3d graphic tools and new file formats have become available since then. However, it still contains useful information, such as details about several of the different file types and a list of errors that can occur during file format conversions. McHenry and Bajcsy suggest that some of these problems can be overcome by using a neutral file format. The students were not aware of the existence of this paper and did not find it during their literature search. The result was that they developed their own evaluation criteria independently and that both papers complement each other.

Huss et.al. (Huss et al., 2002) encourage students to participate in research and to make sure they spend time with faculty. That increases the likelihood that students get good letters of recommendation. Skills and experience gained in undergraduate research are going to be valuable to the students later on. Instructors are advised to encourage students to seek out mentors early on in their undergraduate careers. Although the results of the study conducted by Huss et.al suggests that it would be more difficult for students at larger universities to establish those kinds of relationships, this would be balanced out by greater access to research experience (Huss et al., 2002).

GOALS

The original goal of this project was twofold. First, to give the students an opportunity to acquire and improve skills useful in graduate school. Second, to produce a paper that would provide a clear overview of existing 3d graphic software and the different 3d file formats. This project was intended to benefit the participating students, the 3d graphics community, and the instructor in the following ways:
The students learned how to organize and write a meaningful survey paper. They developed the ranking algorithm by which the different programs and file formats were compared. These analyses were presented to the instructor during one of the weekly meetings. During the course of this project the students were able to improve their presentation skills. For example, the PowerPoint slides were less cluttered when comparing later drafts to the earlier ones and the wording improved greatly. The students also learned the importance of limiting the scope of a research

project by realizing how time consuming it would have been to examine every single program and every single file format.

The paper written by the students was originally supposed to be submitted for publication in the Journal of the Kentucky Academy of Science. It was designed to be used as a guide to help game developers, educators, graphic designers, and CGI animators decide which software and which file formats to choose for their work. Due to time constraints the paper was not submitted, however one of the students improved the algorithm, collected more data and developed this project into her honors thesis.
The findings of this research project have helped the instructor to determine which software and which file formats to use for teaching a course in Computer Graphics. The results will also be useful for future research projects.

The project had several milestones that the students needed to accomplish:

1. Research different file formats and software tools and pick the ones to be represented in the study.
2. Develop a formula to evaluate the file formats as well as the software tools.
3. Gather results and draw a conclusion from those results.
4. Write a paper that could be published and present the project at a conference.

RESEARCH DESIGN

The students met with the instructor on a weekly basis to discuss findings and results. They divided up the tasks given by the instructor amongst themselves and reported on their progress or any obstacles they discovered. The instructor guided the students how to write and format a successful survey paper that will be submitted for publication in a peer reviewed journal. The students were given a great amount of autonomy how divided the tasks up among themselves and contributed to roughly equal parts to the project.
The paper written by the students consists of a detailed description of the project and includes descriptions of the software and the file formats as well as comparison tables.

The students found overall 81 different programs for creating and editing 3D graphics as well as 144 different 3D graphics file-formats. The 5 most commonly used programs and the 10 most commonly used file-formats were chosen for further study based on a number of attributes, which were determined by the students.

The students developed a formula to rank the different programs after determining what the most desirable attributes in software and file formats would be. They selected the following four attributes: Popularity, file-format compatibility, cost, and user-friendliness. Each attribute was calculated individually and multiplied by a weight W. A similar formula was used to evaluate the different file formats.

$$W1\left[1-\frac{c}{(c+a)}\right]+W2\left[\frac{x}{5}\right]+W3\left[\frac{y}{(y+b)}\right]+W4\left[\frac{z}{10}\right]$$

The formula above is the one the students developed for evaluating 3d graphic programs. This formula takes into account popularity, file-format compatibility, cost, and user-friendliness of the software that is being evaluated.
W= the weight for each attribute.
c= the cost of the current software the students were evaluating.
a= the average cost of all software in the current comparison.
x= the score out of 5 for user-friendliness.
y= the average search results of the current software being evaluated across a selection of 4 popular search engines.
b= the average of the compared software's search results across the search engines.
z= the number of compatible file-formats from a list of 10 file-formats for the software being evaluated.

The formula below was developed by the students to evaluate file formats. It consists of components for popularity, file size, and software compatibility.

$$W1\left[\frac{y}{(y+b)}\right]+W2\left[\frac{s}{(s+a)}\right]+W3\left[\frac{v}{5}\right]$$

W= the weight for each attribute.
Y= the average search results returned by 4 search engines on the file-format we are currently scoring;
b =the average search results of all of the file-formats in the current comparison over the used search engines;
s= the file size of a sample object in the file-format currently being examined;

a= the average file size of the same sample object converted to the other compared file-formats;
v= the number of compatible software for the current file-format. (Kennedy, 2016)

DISCUSSION

During the course of the project, the students encountered various obstacles, which prompted discussions amongst the group on how to overcome these obstacles in the most effective way. The students came up with their own creative methods to solve the problems and agreed on which solution to implement. For example, it was decided to use the popularity of the software packets as one of the search criteria. For evaluating popularity, search engine results were counted. One of the software tools being evaluated was Blender. Of course when typing the word Blender into a search engine, one will inevitably get results that are completely irrelevant to 3d graphics. The solution the students came up with to address this problem was to use the search term "Blender 3D Software". For example, most search engines, especially Bing, returned a large number of websites advertising kitchen appliances and only very few websites about the software when the word "Blender" was entered. The students solved this problem by entering the search term "Blender 3D Software" into any search engine, which yielded mostly relevant websites.

For measuring user friendliness, the students developed a checklist if a software tool had certain features to make it more user friendly and calculated an overall score based on the number of check marks on that list. This example shows how the students learned in their research how to use methods for measuring criteria and how to combine, modify, and fine tune those methods.

This project has encouraged one of the students to continue it on her own during the following semester and develop it into her honor's thesis (Kennedy, 2016). Her efforts resulted in a much more comprehensive and sophisticated paper. This student also decided to apply for graduate school.

This student's honor's thesis addresses many shortcomings of the original paper and extends the scope of the investigated file formats. It also describes how the algorithms have been improved in terms of accuracy and inclusiveness and includes a new and revised ranking formula that increased the number of evaluation criteria for software from four to nine. The number of criteria to evaluate file formats was changed as well, from three to five, by removing one attribute and replacing it with three more relevant ones. The individual components of each formula have been revised as well.

Even though the paper was of good enough quality to be published after some revisions, the students had all meanwhile graduated and were not interested in revising the paper and publishing it.

Financial factors, such as the prohibitive cost of programs like 3d Studio Max prevent the evaluation of certain software. Free trial versions of some of the software tools that are available now were not available at the time the project was conducted. There were also time limitations, since only one semester was available to conduct the research, write the paper, and prepare the PowerPoint presentation. Despite these obstacles, this project was successful in the end.

CONCLUSIONS

The project has been concluded and the participating students received 3 credit hours toward their degree for their work. The students presented their project at the annual Kentucky Academy of Science meeting in November of 2015 at Northern Kentucky University. Since only one student was allowed to present at the conference, the presenter was voted by the group. It was originally planned to publish in the Journal of the Kentucky Academy of Science. It was not possible to format and refine the paper to publishable quality due to time constraints.

In the future, students will need to be taught how to conduct a more thorough literature review.
It is too early to say if this course actually prepared students well for graduate school. It convinced one student to apply for graduate school and encouraged the others at least to consider applying.

New software is being released and new file formats appear, while older ones become obsolete. For example XNA Game Studio having been replaced by Unity as most widely used 3d game engine. The data in the paper may no longer be relevant five years from now, but the algorithm developed by the students might be useful to calculate new data.

REFERENCES:

Ampaw, F. D., Jaeger, A. J. (2012) Completing the Three Stages of Doctoral Education: An Event History Analysis, *Research in Higher Education*, Vol. 53, No. 6, pp 640–660

Carpenter, A., Derbinsky, N., Yang-Keathley, Y. and Suresh, D. Graduate School Preparation within an Undergraduate Program (Work in Progress)

Center on Education and the Workforce; US Census Bureau (2013) College majors most likely to obtain a graduate degree in the U.S. 2013

Chang, J., Schnoebelen, K, and Smith, S. (2007) Beginning and Succeeding in Graduate School, JOURNAL OF PERSONALITY ASSESSMENT, Vol. 88, No. 2, pp 250–253

Council of Graduate Schools (2013), Completion and Attrition in STEM Master's Programs Vol. 2, No. 5

Hall JD, O'Connell AB, Cook JG (2017) Predictors of Student Productivity in Biomedical Graduate School Applications. *PLoS ONE* Vol. 12, No. 1

Huss, M., Randall, B., Patry, M., Davis, S., Hansen, D.(2002) Factors Influencing Self-Rated Preparedness for Graduate School: A Survey of Graduate Students, *Teaching of Psychology* Vol. 29, No. 4

Kay, D. G. (1998) Computer Scientists Can Teach Writing: An Upper Division Course for Computer Science Majors, *ACM SIGCSE Bulletin*, 30(1), pp 117-120

Kennedy, K. Adjustable Software and File Format Grading Algorithms for the 3D Graphics Industry, unpublished, 2016.

McHenry, K. and Bajcsy, P.(2008) An Overview of 3D Data Content, File Formats and Viewers, *Technical Report ISDA*08-002, 2008.

Oswalt, S., & Riddock, C. (2007). What to do about being overwhelmed: Graduate students, stress and university services. College Student Affairs Journal, Vol. 27 No. 1, pp 24-44

Pabst, E. (2011) Blissful Blundering: Embracing Deficiency and Surviving Graduate School, *The Geographical Bulletin* 52: 92-9492

Pilskalns, O. (2009), An entrepreneurial approach to project-based courses, *Computer Science Education*, Vol. 19, No. 3, pp 193-204

