Evaluation of a Curriculum for Technical Artists

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Abstract

A Technical Artist requires a unique set of skills to act as a bridge between artists and programmers in digital entertainment development. Our newly developed Technical Artist in Games (TAG) program is regulated under the national Higher Education Regulation (HER) in Sweden. This paper analyses the fit between the program and requirements from both the HER and the computer games industry. The analysis is done by evaluating the course content of the TAG program in relation to the HER and thirty job advertisements. The aim of this evaluation is to investigate how well the program prepares students for their future roles in industry.

Categories and Subject Descriptors (according to ACM CCS): K.3.2 [Computers and Education]: Computer and Information Science Education—Computer science education/Curriculum

1. Introduction

A Technical Artist (TA) is a relatively new role requiring both artistic and technical skills to act as a bridge between artists and programmers. The Technical Artist in Games (TAG) program is a Bachelor of Science (BSc) degree in Digital Game Development that started in September 2010. This paper evaluates the skills obtained in relation to those required by the Higher Education Regulation (HER) [rÖ3] regarding a BSc degree. The skills provided by the degree are compared to those currently demanded in the computer games industry. The research questions asked are:

- How can the TAG skill-set be compared with the requirements from the HER and industry?
- Are necessary skills missing from the TAG program?
- How can courses on the program be structured to include missing skills?

This evaluation has several benefits. Teaching and learning on the TAG program is improved when students understand the program structure and how it relates to industry expectations. Reducing student stress, and increasing motivation leads to better preparation for appropriate roles. The university also benefits by having a successful student graduation rate that leads to jobs. Finally, the evaluation can help other educators to structure and teach a TA curriculum. These benefits were illustrated by a recent tutorial at the 2011 Game Developers Conference (GDC) [MGG*11]. This tutorial focused on how to be an effective TA, demonstrating the timely nature of relevant education.

2. The Technical Artist in Games Program

The TAG website and education plans were used to gather information about the program structure. The courses that are part of the TAG program can be seen in Figure 1. First year courses are in green and the second and third year are orange and purple. The TAG program is split into approximately 50% programming and 50% graphics courses. Also included in the graphics part is analog and digital sketching techniques. In addition to the national objectives, described further in Section 3, the following specific objectives are listed for the TAG program. The student must:

- Understand the problems of linking 3D modelling to implementation of 3D graphics programming
- Be able to implement tools and methods for linking 3D modeling and 3D graphics programming
- Demonstrate understanding of 3D modelling, 3D graphics, game programming, and development tools
- Translate a context into a usable game or simulation environment
- Independently seek knowledge and develop skills in the rapidly changing field of game development
- Understand and independently analyse and apply the scientific progress in the development of digital games in general, especially game programming and 3D modelling

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- Understand the process of game development overall
- Understand how their role relates to other roles in a game development project, and how knowledge sharing between them is conducted and can be developed

The discussion presented in Section 6 describes how these objectives are met. The skills described in the program plan for a TA include the ability to bridge various development roles (e.g. between artists and programmers), construction of tools for an easier workload, technical competence, insight in graphical effects, creating demo applications, and develop games in larger projects. The students have access to various relevant software in a dedicated TA lab used for both graphics and programming. This lab also contains equipment for 2D analogous and digital sketching using for example Wacom drawing tablets. The students on the TAG program also have access to 3D printing and scanning devices.

3. The Higher Education Regulation

According to the HER [rÖ3] a BSc degree is awarded when the student has completed course requirements of 180 ECTS (European Credit Transfer System). The direction of these courses is decided by each institution and at least 90 credits should be a gradual deepening within the main field. There are four main components for a Bachelor's degree: (1) knowledge and understanding, (2) skills and abilities, (3) values and attitudes, and (4) an independent project [rÖ3]. The descriptions of each objective is summarised below based on the information in the HER:

Knowledge and understanding: the student must demonstrate knowledge and understanding in their major field of study (*main subject area*). This should include knowledge about the scientific basis of the area (*scientific foundation*) and the methods used within it (*methods in the area*). The student should also demonstrate a deepening knowledge within a part of this area as well as showing an awareness of the current research issues (*recent research*).

Skills and abilities: the student must demonstrate: (1) the ability to search, collect (*seek/collect*), value and critically interpret (*value/critizise*) information relevant to a problem and to critically discuss events, issues, and situations, (2) an ability to independently identify, formulate, and solve problems (*problem solving*) and to perform tasks in a timely manner (*deadlines*), (3) an ability to give oral and written presentations (*written/oral communication*) and to discuss information, problems and solutions in a dialogue with different groups (*teamwork*), and (4) the skills required to work independently (*independent work*) in the field of study.

Values and attitudes: the student must demonstrate: (1) skills in the main field of study and to make judgements with regard to the relevant scientific, social and ethical aspects (*assess society/ethical aspects*), (2) insight into the role of knowledge in society and the responsibility for its use, and (3) an ability to demonstrate the need for further knowledge and to develop their skills (*learn new skills*).

Independent project: the student must have completed an independent project worth at least 15 credits in the main field of study.

4. TAG Program vs. Higher Education Regulation

As shown in Figure 1 there are some areas that could be improved upon in relation to the HER. A tick in the columns indicates that the requirement is fully met whereas a circle that it is partially met. The optional course is excluded from the analysis leaving twenty courses to be investigated. All courses fulfill the requirement of being in the main subject area. In 9/20 courses the scientific foundation criteria is fulfilled. Almost all courses (19/20) covers methods in the area whereas only 4/20 cover recent research in great detail. In 15/20 courses the students practice seeking and collecting skills whereas only in 8/20 they practice how to value and criticize. Problem solving is practiced in at least 18/20 courses. All courses prepare the students to meet deadlines and 19/20 to communicate both orally and in writing. Only 8/20 courses have elements of teamwork whilst all courses practice independent work. None of the courses makes direct assessments with regards to aspects in society or in ethics. In 18/20 courses the students are practicing learning new skills. The skills according to the HER that have received less than 10 ticks have been studied in further detail.

It is clear that the courses could contain more information regarding the areas scientific ground and recent research. Many courses could potentially include further background information to the specific topic and how it has evolved. It is also very important that educators are aware of recent research in the field. As the analysis showed many courses include written and oral communication. In particular in the introductory graphics courses the students reflect on what they have done in writing for each assignment. It would be interesting to incorporate further demands on scientific references in order for the students to read and summarize previous and recent research in the subject area. This would also prepare them better for the final BSc thesis. The analysis also shows that more opportunities could be given in the courses for students to critically evaluate information in given problems, events, issues, and situations. Assignments could be constructed to better train these abilities. The teamwork aspect of the program could also be improved since it is an important factor indicated by industry demands as discussed in Section 5. Recent research and a more in depth knowledge of the specific area does not appear much in the early stages of the program but all courses on level 2 have these elements introduced. One concern is that none of the courses matches the criteria of evaluating the main subject area in relation to aspects in society and ethics. By discussing with an educator on the program the issue was raised that one of the reasons for this could be that teachers are afraid of posing

	Education Plan	Level	Main subject area	Scientific foundation	Methods in the area	Recent research	Seek/collect	Value/critisize	Problem solving	Deadlines	Written/oral communication	Teamwork	Independent work	Assess society/ethical aspects	Learn new skills
1	Foundations in game development (7.5)	G1N	√			o	√			√	√	√	√		
	Introduction to game development and game design														
2	Objectoriented game programming for technical artists (15)	G1N	√		√		√		√	√	√	√	√		√
	Object oriented programming, C#, XNA														
3	Foundations in 3D-modelling and Sketch Techniques (7.5)	G1N	√		√					√	√		√		
	Autodesk Maya, analogous and digital sketching														
4	Mathematics for technical artists (7.5)	G1N	√	√	√				√	√		√	√		√
	Basic mathemathics for a TA, linear algebra														
5	Interior and Exterior Spaces with Drawing Techniques (7.5)	G1F	√	o	√		√	√	√	√	√		√		√
	More Maya, interiör and exteriör environments, sketching, lighting														
6	Objectoriented design (4)	G1F	√	√	√			√	√	√	√	√	√	o	√
	Basic concepts in objectorientated programs, UML, software development														
7	Plugin Construction and Script Languages (3.5)	G1F	√		√		√		√	√	√		√		√
	Integration of game tools, scripting languages, tools for different roles														
8	Character Modelling with Anatomy (7.5)	G1F	√	o	√		√	o	√	√	√		√		√
	Character modelling, anatomy of humans and animals														
9	3D Printing and Scanning of 3D objects (7.5)	G1F	√		√		√		√	√	√		√		√
	Printing of digital 3D models, scanning of 3D objects														
10	Digital sculpting in Zbrush (7.5)	G1F	√		√		√		√	√	√		√		√
	Pixologic Zbrush, importing, exporting														
11	3D programming I (7.5)	G1F	√	√	√	o	o		√	√	√	√	√		√
	3D programming, lighting, mesh, transformation														
12	3D programming II (7.5)	G1F	√	√	√	√	o		√	√	√	√	√		√
	Shadows, spatial datastructures, animation systems														
13	Character animation (7.5)	G1F	√		√		√		√	√	√		√		√
	Human character movement, rigging, weight painting														
14	Advanced animation (7.5)	G1F	√	√	√	√	√	√	√	√	√		√		√
	Motion capture, blend shapes, advanced rigging, scripting														
15	From graphics to games - construction of exporters/importers (7.5)	G1F	√		√		√		√	√	√		√		√
	Builds upon plugin course, insight in game development in group, tools														
16	Small game project for technical artists	G1F	√		√		√	√	√	√	√	√	√		√
	Game development with students from the same or other programs														
17	Optional course	G2F	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Chosen freely by student														
18	Special effects	G2F	√	√	√		√	√	√	√	√		√		√
	Introduction to special effects, postproduction, camera effects														
19	Special effects and their implementation	G2F	√	√	√		√	√	√	√	√		√		√
	Implementation of special effects, understanding of 2D and 3D programming														
20	Large game project for technical artists	G2F	√	√	√	√	√	√	√	√	√	√	√		√
	Iterative game development, methods and processes in game development														
21	Bachelor project in digital game development	G2E	√	√	√	√	√	√	√	√	√		√		√
		Total:	20	9	19	4	15	8	18	20	19	8	20	0	18

Figure 1: *Table showing how the TAG courses match the objectives in the HER [rÖ3]. Courses in green are in the first year whereas courses marked with orange and purple are in the second and third year. Level indicates which requirements are needed to undertake the course. The G1N level has only secondary school entry requirements, whereas G1F is at an undergraduate level (having less than 60 credits as entry requirements) and G2F is at an undergraduate level (having more than 60 credits as entry requirements).*

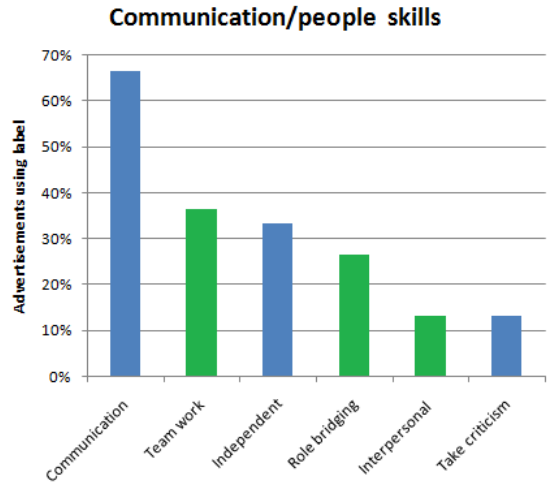

Figure 2: *Communication skills mentioned in the job advertisements. Skills in blue are covered well by the TAG program whereas skills in green could be introduced or improved upon further.*

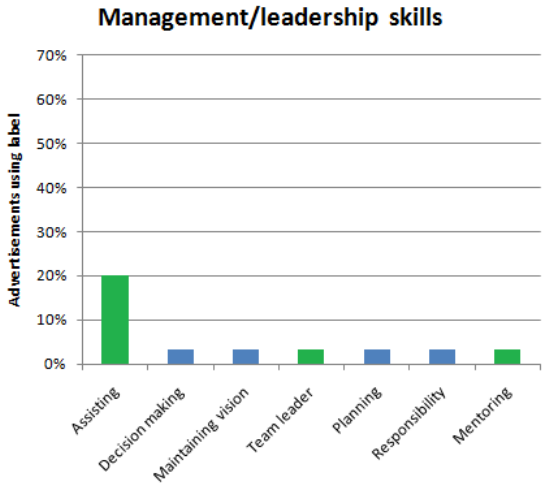

Figure 3: *Management/leadership skills mentioned in the job advertisements. Skills in blue are covered well by the TAG program whereas skills in green could be introduced or improved upon further.*

specific values or lacking the knowledge to cover it successfully. Since the program development is in its early stages these aspects will be included as a result of this analysis.

5. TAG Program vs. TA Job Advertisements

In order to evaluate how well the TAG program fit the demands of the industry the skills were categorized into seven categories: (1) communication/people skills, (2) management/leadership skills, (3) organizational skills, (4) research skills, (5) creative skills, (6) technical skills, and (7) software skills. Thirty TA job advertisements were selected to identify which key tasks and skills are most required. The job advertisements were for positions in the following countries: Australia (1), Canada (4), Holland (1), Sweden (3), UK (7), USA (13), and Worldwide (1). The results of this analysis can be seen in Figure 2 to Figure 8. These graphs show the percentage of advertisements that used a specific label within the seven different categories. As can be seen in Figure 2 excellent oral and written communication skills are the most common occurring skill in this category. These skills are trained in almost all courses at the TAG program as shown in Figure 1 which suggest that the program meet the requirements in this regard. This was also a requirement of the HER [rÖ3] so it seems to match both the program and the industry demands well. The distribution of job advertisements also seem to suggest that many of the TA jobs are available abroad. Considering that the TAG program is mostly taught in Swedish including more communication in English, both in writing and during presentations would be beneficial.

Figure 2 also shows that the ability to work in a team is important. As mentioned in Section 4, teamwork could possibly be practiced to a larger degree at the TAG program. One possibility to practice both teamwork, interpersonal, and role bridging skills would be to collaborate between the different game development programs available at the university. As stated in the education plan there will also be invited speakers from the industry. These can possibly further help the understanding of different roles at a games company. This is something that is still needs to be implemented in the program. The independent work skill and the ability to take criticism are practiced in all the courses. Once again this matches the requirements of the HER [rÖ3] and the program.

Figure 3 shows that management and leadership skills are important. Out of the seven mentioned skills there are three that the TAG program does not directly teach the students. These are assisting, being a team leader, and mentoring others. One suggestion for practicing all these three skills in addition to several of the communication skills could be to allow the students in the third year large game development project to act as TAs for the smaller game development project in the second year for part of the credit points for their course. Even though it would not be possible for all students another option of training these skills would be to work as a teaching assistant within the program courses. To a large extent both the skills within the communication and management/leadership categories would be hard, if not even impossible, to learn by teaching oneself the subject area. Therefore a degree program can potentially contribute to skills which are hard to obtain alone. It is also interesting to note that the

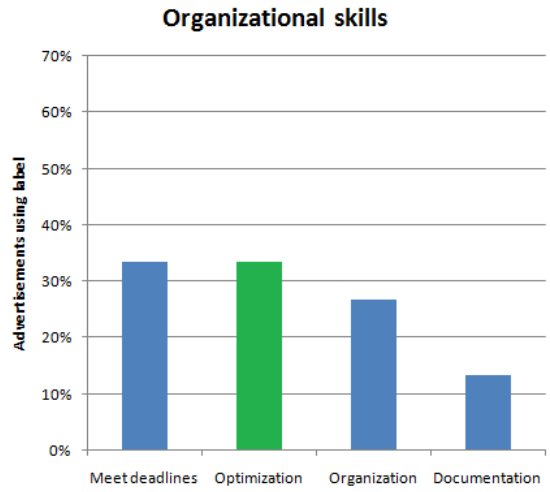

Figure 4: *Organizational skills mentioned in the job advertisements. Skills in blue are covered well by the TAG program whereas the optimization skill in green could be improved upon further.*

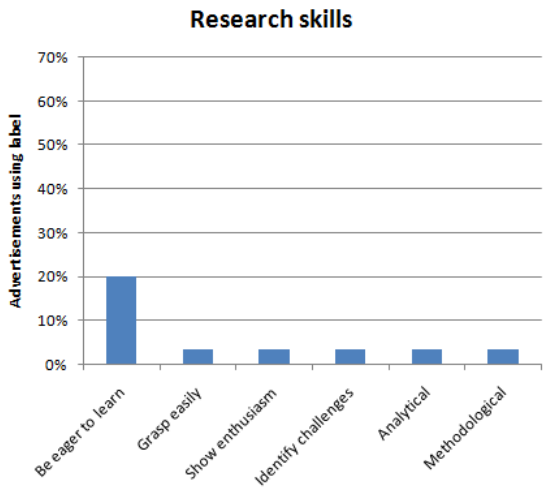

Figure 5: *Research skills mentioned in the job advertisements. All these skills are covered well by the TAG program.*

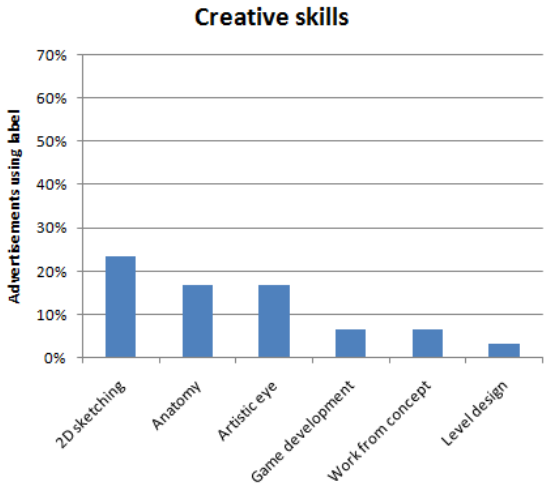

Figure 6: *Creative skills mentioned in the job advertisements. All these skills are covered well by the TAG program.*

HER [rÖ3] does not mentioned management and leadership skills as objectives to reach.

Figure 4 shows that a TA needs organizational skills, including meeting deadlines, optimization, organization, and documentation. All the courses on the TAG program practices meeting deadlines by handing in coursework assignments. Most of these assignments also include organization and documentation of the work. Optimization can also be seen as important for the technical skills section, for example in optimizing a pipeline or process. However, it can be hard to practice optimization skills when the courses on the program are to some degree standalone. In order to practice these skills further a more complete project pipeline or parts thereof would have to be implemented. To implement or simulate parts of a pipeline a possibility would be to allow some coursework assignments to be based on case studies from the entertainment industry.

Figure 5 shows that a TA should be eager to learn new things. As the HER points out an important objective for a BSc student is also to have an ability to identify the need for new knowledge as well as developing ones competence [rÖ3]. It seems that both the industry and the HER agree that this is an important skill. The industry also states that a TA should be able to grasp the subject area easily with an enthusiasm and passion for the subject. Another important research skill for a TA is to identify current challenges and techniques. Other desired skills are the ability to be analytical and methodological. All these skills are also mentioned in the HER [rÖ3].

As can be seen in Figure 6 the creative skills include several useful abilities for a TA. It is interesting to note that artistic topics are mentioned such as traditional drawing skills in 2D, knowledge about human and animal anatomy, and having an artistic eye. Other creative skills mentioned are knowledge about game development, level design, and working from concept art. These skills are incorporated in the courses on the TAG program in year one. In year two the TAG program also includes a course in 3D printing and scanning which allows the students to physically print their own 3D models. This adds an extra dimension to the classical 2D concept art workflow. This could potentially help conveying

the overall artistic vision in a project. The students in year two this year constructed their own boardgames using their own modelled 3D printed objects as pieces to move with.

As can be seen in Figure 7 the technical skills matches our program well. What could be improved upon is possibly the work as mentioned earlier with tasks relating to the pipeline and process. This is a difficult problem to tackle but as suggested previously maybe a pipeline more similar to the one in industry could be applied to some of the TAG courses. Another area which is currently underdeveloped would be in compositing and post processing. This might be more critical for a TA position in special effects however it could potentially be incorporated in the final year's special effects courses on the TAG program. It is interesting to note that character rigging and scripting was the most common mentioned technical skills. Although the TAG program teaches these skills to some degree it might be worth focusing more of the programming efforts and scripting tasks towards character rigging.

Figure 8 shows that the TAG program meets the requirements of the industry well. All software skills are or could be practiced. However, the program does not teach Flash, Actionscripts, PHP, HTML, XSI, Windows, or Linux even if some of these are available for the students to use. In particular 3ds Max and After Effects are programs that might be incorporated further in the future. It is very interesting to note that the 3D modelling package chosen as the main program in the TAG degree also is the one sought after in the industry. MEL and Python scripting are also mentioned very often. All these are taught to a large degree at the TAG program. Surprisingly not that many TA job advertisements mentioned C++ or C# which the TAG program includes.

Finally, another skills which is practiced both in the program as well as mentioned in the HER [rÖ3] and by the industry is problem solving. In order to practice problem solving our program uses problem based learning (PBL). As Biggs [Big02] describes PBL can be a good example of aligned teaching. Constructive alignment (CA) [Big99] is the idea that you should assess what you teach and this should consider what you want the students to learn. This is an important topic which can help students with different goals obtain a deeper understanding. Bidarra [Bid09] also argues that a project based education, such as digital game development in a group, can be highly motivating, useful, and a good way of applying CA. PBL is also known to train skills such as problem solving, teamwork and individual work, communication and decision making skills, and the eagerness to learn [SM10]. It also trains the students to question, evaluate and value the current knowledge [SM10].

6. Discussion

To a large extent the content of the TAG program, the HER, and the industry demands seem to correlate fairly closely. By studying the objectives in the program plan it is clear that improvements can be made. By studying the HER it was found that a scientific foundation and recent research could further be included in the TAG program. Since one objective was to understand and independently analyze and apply the scientific progress in the development of digital games it is felt that this could be enhanced. Another goal was to understand the whole process of game development and all elements contained in this process. As Figure 7 shows the pipeline/process could be practiced to a larger extent. Finally, the last objective which could be improved upon was to understand what roles exist in a game development project, and how knowledge sharing between them is conducted and can be developed. As Figure 2 shows role bridging is an important skill listed by the TA job advertisements.

The ability to value the main subject area in relation to ethics and society was found to be missing so far. A solution to this problem could be to invite a speaker who has published work in the area of ethics and game development [Sic05]. Sicart [Sic09] recently published a book on the topic of ethics in computer games. Sicart argues that computer games are ethical objects and that ethics is involved in many aspects of gaming, for example in playing games and in ethical responsibilities of game designers. There has been a intense discussion over the amount of violence in gaming and its possible effect on society [DLN07]. These are aspects which could be the foundation for a debate on the TAG program. Further, Svinicki and McKeachie [SM10] discuss how ethics and values can be taught. Svinicki and McKeachie [SM10] argue that we always teach our values, if not through direct instructions then through our behaviour. They point out that collaborating with others often can have a positive effect on attitudes and values [SM10]. Finally, they highlight that a lecturer is often facing ethical decisions. They state that sarcasm, favoritism, and failure to respect diversity of student's cultures, values, and attitudes can all be ethical issues. Other examples they mention include handling requests that differ from a syllabus policy, dealing with handicaps and disabilities, dealing with inappropriate comments from students (they ask if we criticize the idea or the person), referencing material used, questioning whether assignments and assessments are dictated by student learning or our need to save time, and finally if we are ethical in our use of licensed software [SM10]. They way educators behave in these aspects model values. Finally, Svinicki and McKeachie highlight the importance of teaching our students how to reflect since they argue that "conscious reflection on values is perhaps the cornerstone of the ethics of teaching and the teaching of ethics".

As described earlier the TAG program aims to have an equal split between graphics and programming. It is interesting that the program appear to be more technically oriented than what is required in the industry, for example by including more programming in C++, C#, and Python. This is maybe the result of being an institute of technology. Sev-

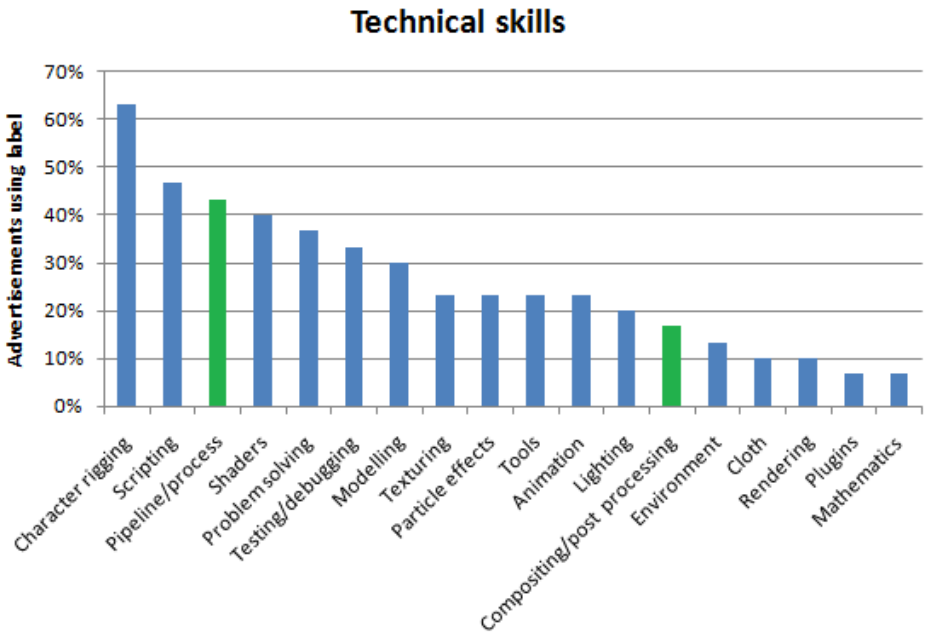

Figure 7: *Technical skills mentioned in the job advertisements. Skills in blue are covered well by the TAG program whereas skills in green could be introduced or improved upon further.*

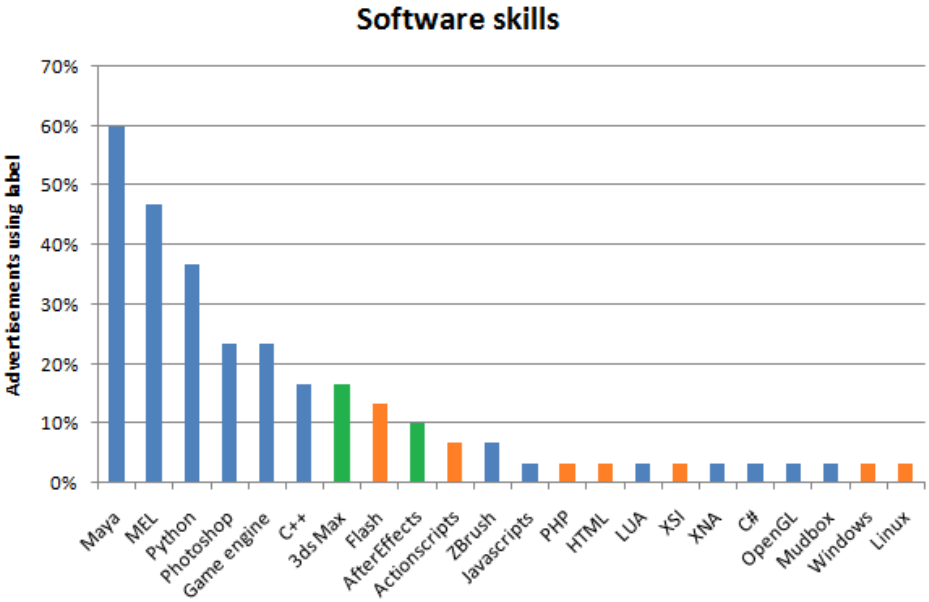

Figure 8: *Software skills mentioned in the job advertisements. Skills in blue are covered well by the TAG program whereas skills in green could be introduced or improved upon further. There is no specific plan to introduce the orange skills in the TAG program.*

eral job advertisements also reported programming skills to be a bonus feature. This indicates that our students could be well prepared for a role that might not exist in the current market making them more employable in the future. A small anonymous poll with 25 participants (1 female and 24 male, age range 19-30) was conducted to evaluate how the students rated their current interest in each topic, graphics or programming, after a year of their degree. The students were told to list which area they felt most interested in, they were free to write on or the other, both, or any percentages they wanted. Each ratio was added to either the graphics or programming topic. This poll showed that graphics received 69% and programming 31% of the interest. It will also be interesting to explore how these ratios might change over time.

Alterations could also be made to TAG programs to incorporate setups which practice skills that are not traditionally included in game development programs. For example management and leadership skills. These skills could potentially be practiced by allowing collaboration between classes in different years within the TAG program or in collaboration with other programs. Another interesting result of the analysis is that what is commonly listed as general abilities in course description plans are in this case skills specifically important for a TA. These include skills such as problem solving, communication, independent work, and team work. It seems to be a difference between classical general abilities and in this case specific and contextual abilities with the same name. Potentially course description plans should be revised to take these general skills into account as objectives themselves. For example, communication was identified as one of the top skills from the TA job advertisements. This skill would in many courses be listed as a general ability whereas we suggest it could be suitable as its own objective.

Being able to demonstrate a good portfolio was also mentioned in the TA job advertisements. This is something that the TAG program tries to accomplish by actively encouraging the students to document and save the progress of all work they do for the duration of their studies. It is very interesting that they document the entire process since it can show examples of how they did go about solving a problem for example. This is an important skill that companies look for in a successful TA. By having a TAG lab in which the students can sit and work with 3D modelling and/or 2D sketching it creates more like a studio feeling. This is a dedicated lab in which both theory and practice take place. As reported in Svinicki and McKeachie [SM10] in a studio learning and practice are tightly integrated. They also state that "there is a strong sense of importance for combining the theoretical with the practical, or combining the knowledge with the ways knowledge is constructed" [SM10]. The TAG lab also allows the students to have access to concepts and problem solving in the same space. Svinicki and McKeachie [SM10] state that this hands-on experience can deliver fast results.

7. Conclusions and Future Work

The aim of this paper was to evaluate what skills TAG students will possess in relation to what is required by the HER and industry. Overall the TAG program seems to match the HER and computer game industry quite well. This paper has shown that some aspects could be improved upon further. Additional work has begun in order to identify what background experiences the students on the TAG program have before starting. For example, since the program is split into an equal division of graphics and programming courses it would be interesting to study and follow the progress of the students in both types of courses. Due to this novel degree it is interesting to learn more about the background of the students in order to know how they might cope with various courses on the program. Work has begun to get the students to rate their programming and graphics experience at the start of the program. This could be compared against each other, but future evaluations could also establish how hard each topic is to learn. A survey has also been conducted with eight TAs working in the entertainment industry, which will be analysed in future work.

8. Acknowledgements

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