Construction trial of a practical education curriculum for game development by industry/university collaboration

Koji Mikami†, Taichi Watanabe†, Katsunori Yamaji‡, Kenji Ozawa‡, Akinori Ito†,
Motonobu Kawashima‡, Ryota Takeuchi†, Kunio Kondo† and Mitsuru Kaneko†
†Tokyo University of Technology
‡ Premium Agency, Inc. / Tokyo University of Technology

1. Outline and Background

In recent years, a deep understanding of game development procedures has been needed in order to keep up with advancements in game technology. At the same time, game education is on the rise among American and European Universities[1][2][3][4][5]. Also, a curriculum framework has been created by the International Game Developers Association (IDGA) with positive progress shown by cooperating with the industry[6].

Games, together with *manga* and *anime* as represented by Japanese technological advances are highly evaluated in other countries. As there has been no consistent education program designed specifically for game production in the Japanese higher education institutions, the recent development of a game oriented curriculum has been strongly welcomed by the game industry. However, when the project was initiated there was no such curriculum for a 4-year Bachelor's program. As a result, organization of teaching and production methods was delayed and the industry developed their own unique production style. Due to this, production methods became a trade secret and complicated the relationship between universities and industry. Hence, there are only lectures conducted by part-time teaching staff hired by several colleges.

At the Tokyo University of Technology (TUT), we have designed a curriculum in collaboration with Premium Agency, Inc that aims to offer training in the practical aptitudes that are demanded by the game development industry. We have added lessons to the traditional faculty curriculum that combine lectures and exercises in a game development context. As a result, the number of students that are acquiring knowledge by consistently attending lectures and thus gaining experience in a wide range of concentrations such as programming, CG and planning from the 1st to the 4th Year is growing.

2. Problem Statement/Dilemma

In game development, skills such as creating proposals, script, design, program, graphics, sound and much more would be necessary. Due to this, a number of teaching staffs are needed. It is difficult to create, using limited resources, an educational system that supports a wide-range of skills.

Also, game development only becomes possible when these skills are combined. Hence, it is hard to complete lecture courses and workshops within one semester as moving from game proposal to game development will require more time.

Furthermore, for practical training curriculum, there is a need to cooperate with veterans in the industry and have them their experience from the actual working environment.

3. Review of Current Situation of TUT

At TUT, we led other universities in Japan by opening the School of "Media Science" (capacity: 400 students) in 1999. The school effectively prepared curriculums combining lectures and exercises that were adopted as the "Organization and practice of media-related exercise class" project by the 2005 Support Program for Distinctive University Education of the Japanese Ministry of Education Culture, Sports, Science and Technology (MEXT).

4. Program Details

Based on the curriculums in use at the School of Media Science, we have attempted to build a curriculum aimed at cultivating international human resources in support of a comprehensive game development program in accordance with the needs of the Japanese game industry.

Hitherto, the technologies required for game production have been scattered over a wide range of fields. However, as TUT has experts in real-time CG technology and animation technology, we have been able to offer tuition that covers a wide range of disciplines. On the other hand, since the most capable human resources tend to be spread over so many different industries it has been difficult to provide a consistent education program, even when a small number of teachers from outside of the university were invited to provide support. Yamaji as an owner of a game development company coordinated human resources from within the industry based on international experience in game development. It therefore became possible to create a curriculum for an integrated educational system in the fundamental game production technologies based on industry/university collaboration.

Copyright is held by the author / owner(s).
SIGGRAPH Asia 2009, Yokohama, Japan, December 16–19, 2009.
ISBN 978-1-60558-858-2/09/0012

4.1. Curriculum

Fig. 1 shows the system of exercise subjects that are available at TUT. These subjects include “basic exercises” that are compulsory to the 2nd Year students, the “core exercise” for the 3rd Year students and the “project exercise” given to students from the 1st to 3rd years as special exercises offered from an early stage. With each subject accepting the setting of a sub discipline, a framework for prompt response to student needs is established. This approach enables students to either challenge the same theme from the 1st to the 4th Year or to learn different technologies according to their learning stages. Game education also includes two special course lectures in addition to the exercise curriculum described above. Concurrent learning via lectures and exercises allows the students to learn the subject both through theory and practice.

<table>
<tr><th>1st year</th><th>2nd year</th><th>3rd year</th><th>4th year</th></tr>
<tr><td>Fresher tutorials</td><td rowspan="2">Media basic exercise: 4 themes (compulsory), 6 weeks/theme</td><td rowspan="2">Media core exercise: 2 themes (optional), 13 weeks/theme</td><td rowspan="3">Graduation research</td></tr>
<tr><td>Computer operation exercise</td></tr>
<tr><td colspan="3">Project exercise</td></tr>
</table>

Fig. 1 Exercise System at TUT School of Media Science

Graduation research (thesis) is required of 4th Year students, who adopt specializations in their studies. As TUT includes graduate programs for bionics, computer science and media science, the postgraduate students can also go on to continue their studies to master and doctoral courses. In this way, TUT has adopted game production as one of the projects based on the framework of the School of Media Science.

In the first semester of Year 1, students will not learn how to use digital tools used in game development. Prototyping methods are effective in designing games[7], but creating a prototype is time consuming. The aim of this workshop is to educate students in game mechanisms. Students add and change rules of physical(traditional) games such as "hide and seek" and are required to make a presentation to all other students. The modified games are then test-played, the rules further revised, and a final presentation is made. This workshop lasts approximately 12 hours spread over the span of 4 weeks. The workshop is suitable for the first year students because it demands a lot of communication.

In the 2nd Year, students will choose a concentration based on their interests. Game production requires two different types of human resource, those that are oriented to creative matters (game creators) and those with commercial interests (game producers). Our curriculum intends to cultivate practical human resources by providing an education from both perspectives and then linking them principally by exercises. Fig. 2 shows an example of the configuration of the game curriculum.

As an education program designed specifically for practical game production, this curriculum was applied to and adopted by the university reform promotion subsidy (university reform promotion project) entitled “Support for Good Practice for modern education needs”.

<table>
<tr><td>Entrance</td><td></td><td>Game creator</td><td>Game producer</td></tr>
<tr><td rowspan="3">1st year:</td><td>Sem.1</td><td colspan="2">Project workshop I
(Understanding the algorithm of Analog play)</td></tr>
<tr><td></td><td>⇓</td><td>⇓</td></tr>
<tr><td>Sem. 2</td><td colspan="2">Project workshop II
(Devising an original plan)</td></tr>
<tr><td></td><td></td><td>⇓</td><td>⇓</td></tr>
<tr><td rowspan="6">2nd year</td><td rowspan="2">Sem. 1</td><td colspan="2">Basics of game producing
(Lecture)</td></tr>
<tr><td colspan="2">Project workshop III
(Learning the game material production technique)</td></tr>
<tr><td></td><td>⇓</td><td>⇓</td></tr>
<tr><td>Sem. 2</td><td colspan="2">Game producing techniques
(Lecture)</td></tr>
<tr><td></td><td>Project workshop IV
(Leaning advanced production techniques)</td><td>Project workshop IV (Management)</td></tr>
<tr><td></td><td>⇓</td><td>⇓</td></tr>
<tr><td rowspan="3">3rd year</td><td colspan="3">Core workshop: "Game producing"</td></tr>
<tr><td></td><td>Project workshop V, VI (Experimenting production techniques)</td><td>Project workshop V, VI (Experimental management)</td></tr>
<tr><td colspan="3">⇓ Presentation at Tokyo Game Show ⇓</td></tr>
<tr><td rowspan="3">4th year</td><td colspan="3">Graduation research “Game science”</td></tr>
<tr><td>⇓ ⇓</td><td>⇓</td></tr>
<tr><td colspan="3">Job finding/ Starting businesses</td></tr>
<tr><td></td><td colspan="3">Graduate school (R&D course)</td></tr>
</table>

Fig. 2 Game Education Curriculum

4.2. Education Resources

In order to implement an educational contents system that is not limited to producing games, it is essential that the educational institution possesses the facilities and organization capable of promoting the production and accumulation of expertise. Therefore, at TUT we have established the "Creative Lab (C_LAB)" in the Katayanagi Advanced Research Lab as a foundation for studying contents production techniques. The foundation is attached to the university and the laboratory is conducted under the guidance of Kaneko and the authors of this paper. By inviting outside advice from persons with relevant experience and knowledge, the Creative Lab has gathered young researchers and production staff to begin the study of contents production technology. It has thus built an effective

system for providing practical education throughout the process.

One of the special features of the educational activity provided by the lab as a research organization is the practical education offered by participation in industry/university/government collaborated projects. The permanent presence at the University of full time young researchers that are able to utilize advanced facilities and technologies requiring high skills has made it possible to keep such facilities working continuously. This strategy allows them to be available anytime for educational purposes and research whenever they are required. Collaboration with private enterprise companies also becomes easy. When a student participates in a project in which he or she is interested in, such a student can join as an assistant to the researchers at the same time as actually participating in a project. TUT makes full use of its highly developed environment and human resources and is capable of providing students with an education close to the practical work by letting them work in OJT and internships.

The staff giving the game-related exercises and lectures that are discussed in the present paper include full-time and part-time teachers as well as researchers from the Creative Lab. The details of the teaching staff are as shown in Table 1.

Table 1 Teaching Staff List

* Underscored names indicate Course Tutors and the names in *italic* indicate the C_LAB staff.

Role	Teaching staff
Director	Mitsuru Kaneko
Graduate research	Taichi Watanabe, Koji Mikami, Katsunori Yamaji, Kenji Ozawa
Core exercises	Koji Mikami, Mitsuru Kaneko, *Tagiru Nakamura*, Kenji Ozawa
Project exercises	Koji Mikami, Taichi Watanabe (Producing) , *Akinori Ito* (Sound), *Motonobu Kawashima* (Graphics), *Tagiru Nakamura* , Ryota Takeuchi (Programming)
Lecture subjects	Katsunori Yamaji (Basic of game producing, game producing techniques)
Special lecturers	Sony Computer Entertainment, Microsoft, Game Republic, EnterBrain, Tohmatsu Consulting, etc.

5. Research Projects

The projects that are considered in this paper include "Game Science" research projects within the framework of graduate research and industry/university collaborative projects joined by the C_LAB, etc.

5.1. Graduation Research

Selection: The graduate research project sets a quota the permitted number of students. Students apply for their desired projects, and if the number of applicants exceeds the set project limit, the project tutors are permitted to select which students to accept. In fact, the number of applicants to the Game Science Projects have been exceeding the program's capacity greatly since its establishment in 2006 and student selection is performed every year. The selection evaluates the projects and work that each student has achieved rather than the GPA (grade point average) score, etc. Table 2 displays past student application data. Table 3 shows the share of applicant fields and that of the selected fields.

The trend shows that the selection share of the students majoring in planning (scenarios) is the least. This is because there were many students who were not proficient in another field and thus had to select the planning (scenarios) field by default. On the other hand, many of the students applying for the programming projects had some understanding of games and other basic knowledge so the probability of selection with them was high.

In the project exercises that are positioned as leading to graduate research, many of the students interested in game production are tending to accept the importance of acquiring programming skills. Such a high awareness of programming from the entrance stage to actual game production is not found in other projects. This is clearly different from the recent trend where students avoid engineering courses.

Table 2 Selection Data

	Capacity	Applicants	Selected students
2006	16	59	24
2007	16	39	19
2008	20	43	21

Table 3 Field Trend Data

Field	Applicant share	Selection share
Planning (Scenario)	40%	10%
Programming	30%	50%
Graphics	25%	30%
Sound	5%	10%

Research topics: In the Game Science Project, the students personally conduct data collection and propose their own research themes. The teacher judges whether or not the proposed theme is feasible and approves it for graduation research if it is considered to be so. Basic CG research is the foremost theme for the present but there are also other popular themes such graphic representation techniques, usability studies, 3D audio and scenario analyses. Some of the theses written in the past are listed below.

- Application of "boundary blur" to CG.
- Elastic body deformation accompanied by phase shifts
- Energy wave representation with volume rendering.
- Rendering technique to add American comic atmosphere.
- Crowd simulations in the context of the behavior of sardines

Activities outside the university: The games produced as a result of graduation research and project exercises were exhibited at Tokyo Game Show 2007 and 2008 as shown in Fig. 3, 4, 5 and 6. The Tokyo Game Show is participated mainly by vocational colleges and exhibitions related to academic research are relatively few. Nevertheless, featuring research goals and game production issues at an international event of the industry has made it possible to maintain motivation for research and game production that often takes a long time as well as obtaining feedback regarding the research from those who are actually within the game industry.

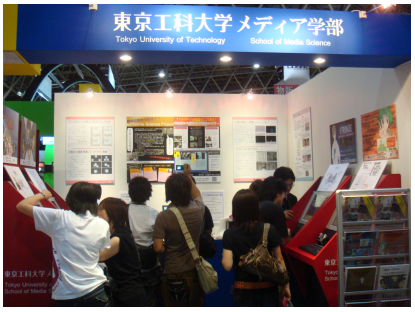

Fig. 3 Exhibition at Tokyo Game Show 2007

Fig. 4 Sample of Exhibited Poster at Tokyo Game Show 2008

Fig. 5 Sample of Exhibited Game at Tokyo Game Show 2008

Fig. 6 Sample of Exhibited Game at Tokyo Game Show 2008

5.2. Industry/university collaboration in research

The Creative Lab plays the central role in advancing a large number of research projects in collaboration with Premium Agency, Inc. Among them, research projects related to game production are introduced below.

Research related to motion generation technology using MOCAP : A motion generation experiment using the motion capturing system owned by TUT is underway. It includes the study of advanced capturing techniques as well as the study and practice of practical capturing techniques assuming that their application is targeted on actual contents. This research involves researchers and a large number of students from the School of Media Science. Figs. 7 and 8 show examples of work handled in this experiment.

Fig. 7 Example of a Detailed Facial Expression Capturing Study

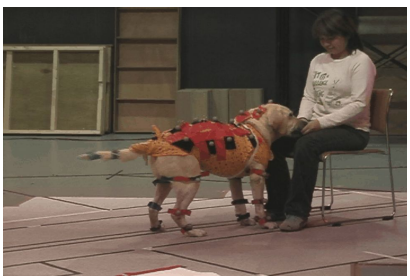

Fig. 8 Example of Animal Motion Capturing Study

R&D for remote training materials: A variety of dedicated software is used in the production of contents including games. As many of the software programs incorporate various functions, their operations also tend to be complicated. As a result, learning about

software issues is an important part of contents production education. In this research, teaching materials as shown in Fig. 9 are researched and developed in order to teach students both about the technology necessary for more practical content production and the acquisition of software operation skills.

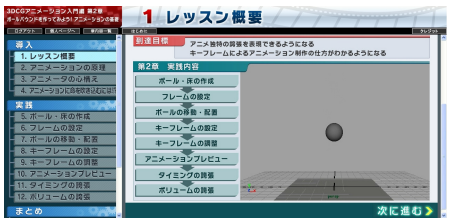

Fig. 9 Example of training Material Contents

Game development process management system study: The contents production uses a large number of specialized processes before completion of the product. These processes vary widely depending on the form and genre of the contents. Technology for managing the production processes is as important as is the production technology. In the context of game development, other factors such as program debugging are involved additionally. This research consists of a study of process management systems as shown in Fig. 10.

Fig. 10 Screen shot of the Process Management Software "B-TRAQ"

6. Evaluation

The present attempt was started in 2004 and the curriculum was completed in the academic year 2008. The "pre-posttest" method[8] is capable of, to a certain degree, measuring the effectiveness of an educative curriculum. However, as we cannot restrict students from studying a number of different subjects during these 3 years, it is difficult to evaluate our curriculum using this method. Therefore, statistical evaluation is limited to some part of lectures and workshops.

6.1. Evaluation for the lecture

A "class evaluation questionnaire" designed to evaluate class performances showed that the game related classes were rated highly by students. These classes were attended by 400 students, corresponding to more than 80% of the students in the same grade.

6.2. Evaluation for the workshop

"Project Workshop": The project based workshop that students applied from 1st Year to 3rd Year has achieved its goal. Students with different skills such as producing, programming, graphics and sound, integrated their skills to complete a final project. Within this environment, the students were able to learn the skills that they really wanted to and how to apply them. And, the fact that they have learned many aspects of game development can be evaluated. Also, an environment where students were able to guide each other was established by conducting workshops for 1st to 3rd Year students in the same class.

On the other hand, practicum from early stage has a demerit where student with undecided objective will find it difficult to participate. Also, students have hard time choosing things that they want to specialize in during early stages. Hence, it was noted that there is a need to coordinate in the case where student wants to specialize in different field than what they wanted earlier on.

"Core Workshop": In the case of "Core Workshop" classes the applicants almost always numbered more than the limits set for the classes. But, because the practicum curriculum was intended for one semester, there had been problem with the schedule and many limitations in their creation. Therefore, in comparison with the project workshop evaluation, the class evaluation questionnaire feedback from students scored lower. Also, the completed creation had a lot of limitation in production.

6.3. Evaluation for effectiveness of education

Although the effect of the new curriculum on job finding is hard to determine from a single survey, It is encouraging that six of the 15 students who have graduated from the "Game Science" research project and have applied for jobs in the game industry have actually found jobs there (including in associated industries).

7. Conclusion

In Japan, industry/university collaboration in the field of games has just begun. As mentioned earlier, when the project was initiated there was no curriculum for a 4-year Bachelor's program in game development within Japan. However, there have been a growing number of ICT faculties that are setting up Game Course in their universities. Furthermore, efforts are being made to set up an educational environment, such as IDGA Japan's effort to translate IDGA's curriculum framework [9].

In TUT, students are actively engaged in collaboration. 80 students are confidently participating in project exercises that are provided as optional classes. These students are acquiring skills independently from the early stages. Collaboration can be regarded as effective in cultivating human resources. However, there are issues that remain with respect to practical technology development.

7.1 Issues

Gap between the research periods of students and the expected results: The substantial period of research in the undergraduate school is less than a year considering other student activities including job finding, and it is not easy to enhance the research capability and achieve significant research results in such a short time. Moreover, some of the technologies required at the practical development site are of low academic significance and are hard to assimilate in the academic dissertations.

Necessity of middleware for facilitating trials and errors: It takes a long time for student become familiar with the technology that is necessary for game development and actual game production; comparable roles are thus allotted in group work. This makes it hard for the student to experience opportunities for actual content development and to benefit from them. In order to solve this problem, it is desirable to prepare development tools and middleware such as "Alice"[10] that can support development without degrading the requisite degree of freedom.

7.2 Future perspectives

In order to enhance the effects of the curriculum even further in the future, it is important that the entire undergraduate school promotes further enhancements and also collaborates effectively with the postgraduate school.

It is therefore desirable to prepare a mechanism that allows students to tackle research at an earlier stage than the graduation research. Doing so allows for more practical joint research and ensures that research of high academic value may be achieved.

The postgraduate school is independently developing the requisite support tools such as the “motion generation tool” that can reproduce different types of motion easily in programs and the “object profiler” that manages the motion history of 3D objects for use in bug analyses. When an integrated support environment can be created by merging these tools it will be possible to prepare a customizable environment that allows students to efficiently experience actual productions.

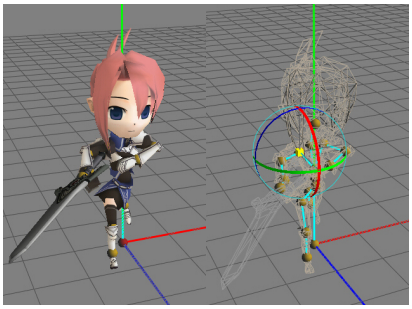

Fig. 11 Originally Developed “Motion Generation Tool”

Acknowledgement

Our game education program was sponsored by Japanese Ministry of Education, Culture, Sports, Science and Technology Japan. (Gendai GP)

References:

[1] University of Southern California : http://cinema.usc.edu/

[2] Entertainment Technology Center, Carnegie Mellon University : http://www.etc.cmu.edu/

[3] Al-Bow, M., Austin, D., Edgington, J. et al. : "Using GreenFoot and Games to Teach Rising 9th and 10th Grade Novice Programmers", Proc. of Sandbox Symposium 2008, ACM SIGGRAPH, pp.55-59, 2008

[4] McDaniel, R. : "Cardboard Semiotics: Reconfigurable Symbols as a Means for Narrative Prototyping in Game Design", Proc. of Sandbox Symposium 2009, ACM SIGGRAPH, pp.87-93, 2009

[5] Fullerton, T. : “Game Design Workshop 2nd ed.”, Morgan Kaufmann Publishers, 2008

[6] IGDA : "Curriculum Framework", http://www.igda.org/academia/curriculum_framework.php

[7] Koivisto, E. and Suomela, R. : "Using Prototypes in Early Pervasive Game Development", Proc. of Sandbox Symposium 2007, ACM SIGGRAPH, pp.149-155, 2007

[8] Chaffin, A., Doran, K. and Hicks, D. : "Experimental Evaluation of Teaching Recursion in a Video Game", Proc. of Sandbox Symposium 2009, ACM SIGGRAPH, pp.79-85, 2009

[9] IGDA Japan Chapter : http://www.igda.jp/

[10] Carnegie Mellon University, "Alice" : http://www.alice.org/

[11] Mikami, K., Watanabe, T. and Yamaji, K. : “SANGAKU RENKEI NIYORU KOTO KYOIKU KIKAN NI OKERU GEEMU JINZAI NO IKUSEI TO SENTAN KENKYU (Fostering of Game Human Resources and Advanced Research at Higher Education Institutions Based on Industry-University Collaboration),” CEDEC2007 Regular Session.

[12] Kaneko, M., Mikami, K and Yamaji, K. : “SENMON KYOIKU NI OKERU SANGAKU RENKEI (Industry-University Collaboration in Professional Education),” Education Reform IT Forum, Section Meeting B-2, 2007.