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Interdisciplinary and International Game Projects for Creative Learning

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ABSTRACT
In traditional computer science courses, students do not often get the chance to experience an entire project cycle, starting from the idea development stage and ending with the final release of a product together with collaborators from different disciplines. Developing a game gives learners the possibility to experience an entire development cycle, to learn how to work in a team, and to learn new skillsets required to create games. Students can profit even more from an interdisciplinary and international setup. In this paper, we describe a first pilot of an interdisciplinary and international student game project, during which students from different backgrounds, and with different nationalities and different learning expectations can work together to develop games. We report on a first pilot with 24 students studying different subjects, such as computer science, law, or biology, in two different countries. First results show that such programs are highly engaging for students, can boost their employability, have a high learning outcome, and raise their interest in international collaborations.

Categories and Subject Descriptors
K.3.2 **[Computer and Education]:** Computer and Information Science Education – *computer science education***.**

General Terms
Design, Experimentation, Human Factors,

Keywords
Computer science education; game development; creative learning; collaborative learning

1. INTRODUCTION
The power of making games to encourage students to learn basic programming concepts is already well known. Creating their own games, parts of games, or mods for games can encourage school pupils and university students to develop an interest in learning programming, also appealing to female students [1][2][3].

For computer science students, developing games is an attractive and also engaging field, since they can learn programming and software engineering by developing real applications with clear goals and visible outcomes [6]. Additionally, computer games challenge computer science (CS) students in a variety of specific CS areas, such as HCI, networking, computer graphics, or AI.

Developing games, however, also requires expertise in many other fields, such as art, 3d modeling, sound design, audio engineering, program management, design, and many more. Thus, to create a successful game, CS students have to team up and learn how to collaborate with students from different disciplines to create art and audio assets, to manage the development process, to design and test the game, and also to promote and present the outcomes. Due to these aspects, game development projects teach participants how to work as a team and allow students to experience an entire project cycle [3].

But not only computer science students, art students, or students from other creative disciplines are interested in developing games. Including experts from different fields, which appear not to be relevant for the game development process, can add interesting new topics, new educational aspects, and innovative ideas. In industry too, more game studios include experts from different disciplines in the development process. For example, in Assassin's Creed, historians were involved in the development process to create a more interesting and realistic historic environment and story [5].

When offering a course on game design and development for our CS students, we wanted to create a similar creative and innovative environment, where they would be able to work together in teams with other disciplines to develop games. To promote internationalization and teach students how to optimize collaboration and communication with remote teams, we have set up the course activities as an international student project. In a first pilot, we ran a program for computer science students at an Austrian university to develop games together with students from an UK university open to all different disciplines such as law, biology, and design.

In this paper, we present course design and experiences of a pilot with 12 Austrian computer science students, who teamed up with 12 British students from different disciplines to develop games together. Developing a game from scratch allows the students to experience an entire project cycle, from the idea finding stage, to the final release and the presentation of a first build. Also, developing a project together with "strangers" and students from different cultures is an entirely new situation for most students. The overall project experience is very close to a development situation in industry and can increase their career potential. The experience of working together with people from other countries should raise their interest in exchange programs, in international collaborations, and prepare them for the global job market.

Our goals in this paper are threefold. First, we want to illustrate our attempt to design an international and interdisciplinary game development program. Second, we want to identify benefits of international and interdisciplinary game development projects from a student's perspective. Finally, we want to report remaining gaps and problems identified to be able to enhance this program in future iterations.

The remainder of this paper is organized as follows. In section 2, we discuss related work. In section 3, we describe interdisciplinary game projects and the proposed process of the course design. Section 4 describes findings and results from our first showcase course and section 5 concludes with overall findings and future work.

2. BACKGROUND AND RELATED WORK

Game development projects have already been shown to be successful tools in the promotion of learning, creative and innovative thinking, and independent problem-solving strategies. In the next section, we discuss project-based learning with a focus on game development projects and game jams.

2.1 Project-Based Learning

Project-based learning, i.e. engaging students in solving and working on authentic problems, is, in particular in computer science (CS), a well-known and important way to teach programming and software development skills. Blumenfeld et al. describe projects, *"in which students pursue long-term investigations of a significant question and produce artifacts that represent answers to those questions have the potential to motivate students and help them better understand subject matter content"* [7]. Students can foster their theoretical knowledge by applying it to real cases [10]. Different studies in programming courses and CS courses show that students achieve a better understanding of the course's objectives [8].

To make use of the above-mentioned benefits, however, the projects for the students have to be compelling and interesting to motivate students and to maximize the learning outcomes. One way to make such projects more interesting is to involve game projects. In particular in the CS curriculum, many students are interested in digital games and their development process. And it is not only men who are interested in games. According to the ESA Fact 2015, 44% of game players are female [18]. The genre and type of games the students are interested in can differ, so it is important to let students make such decisions.

2.2 Game Development in CS curriculum

Different authors have discussed and evaluated the potential of game development for computer science students.

Kurkovsky discusses an approach where they use mobile game development early in their CS curriculum to challenge students at the beginning of the educational program with basics of different CS topics, such as Java programming, mobile development, computer graphics, HCI, algorithms, networking, AI, and database management [4]. Focusing on school education, Robertons and Howells also discuss the potential of game authoring as an opportunity for children to learn in an encouraging and exploratory environment. They also discuss the potential of such a pedagogical model to embrace the possibility for pupils to help and teach each other [11]. Bayliss and Strout discuss the potential of computer games in introductory programming courses with a focus on teaching simple programming concepts, software engineering processes, and ethical implications [6]. El-Nasr and Smith describe their experience with modding (modification of specific parts) existing games in a CS classroom and find that game modding can enhance student performance and that applying CS concepts in such a visual way is highly motivating for students [3].

Many of these approaches are very promising in their ability to raise school pupils' interest in CS, and encourage computer science students to enhance their programming skills and learn different CS concepts as well as allowing them to experience an entire project cycle. However, due to the interdisciplinary character of game development projects, incorporating such a program with interdisciplinary teams (programmers, artists, sound engineers, business experts) in a CS curriculum is a challenge. One way to promote such development projects is the organization of extra-curricular game jam events. In the next section we describe game jam events and their potential for learners.

2.3 Game Jams for Learning

Game jams are events, where people meet for a short time (typically 48 hours) and develop a game together under different constraints (e.g. a specific topic, in a specific style). Game jams have great potential to teach participants prototyping, collaboration, and creative and independent developing [14]. Such events are collaborative opportunities to work and learn in a creative and interdisciplinary environment [12]. Such events and development processes can foster creative thinking, innovation-driven development, and demonstrate the power of rapid prototyping techniques [15].

Game jams have a strong learning component and different studies suggest a positive correlation between students' performance and jam participation [12][13].

Most participants join game jam events to develop games in a group, and to meet people with similar interests and different skillsets [17]. However, due to the nature of game development projects, most participants have a background either in programming, design, art, or sound engineering [16]. Only a few participants with a background in fields such as history, law, or other fields, which are not directly related to the development process, participate in game jams.

In the next section, we propose a project-based learning approach, which brings together computer science students with students from all different disciplines in a jam-like environment to develop games together.

3. INTERDISCIPLINARY AND INTERNATIONAL GAME PROJECTS

Inspired by the interdisciplinary character of game development projects and the reported benefit of engaging students to work on projects, we developed an international and interdisciplinary learning design model to bring together students from different disciplines and nationalities to collaboratively develop games and learn how to work together in teams, both remotely and on-site.

3.1 Objective

The goals of the international interdisciplinary game project were:

- To design a project-based learning experience, which has interdisciplinary and international collaboration involved

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- Increase the students' experience of (remote) team collaboration and supporting collaboration, and communication tools
- Encourage students to learn and master a variety of CS topics by developing games
- Expose students to an entire project cycle, from the idea finding stage to the final release presentation
- Increase students' interest in international collaborations and exchange

The project-based learning experience was organized into three main stages. (1) The team formation stage, (2) the idea and design developing stage in a remote collaboration setup, and (3) the development stage in an on-site jam environment. The single stages of the program are illustrated in figure 1.

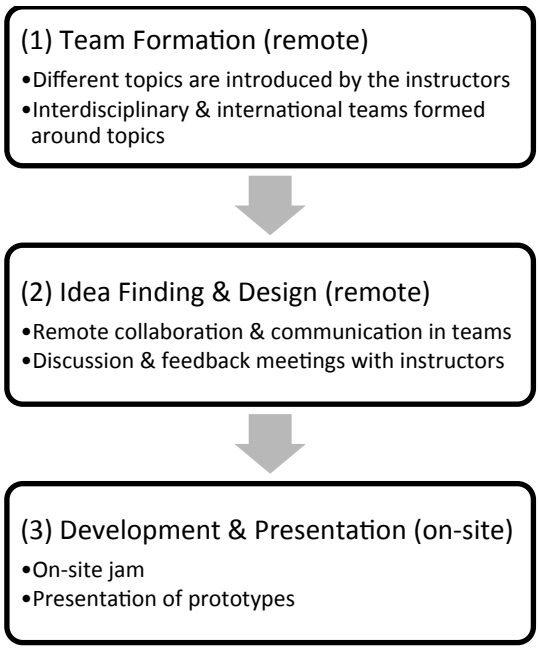

Figure 1. Stages of the interdisciplinary international learning experience on project-based game development

The next sections describe the setup of the interdisciplinary & international game project in an international cooperation between an Austrian University and UK-based university.

3.2 The Setting

In the course "Game Design and Development", Austrian computer science students learn the basics of how to develop games, basics of the development environment Unity, and software project management basics with a focus on iterative development processes. In previous iterations of this course, students worked on game projects together with other students in the same course at the same university. For this iteration, students from this course were able to apply for the international interdisciplinary project-based learning activity as part of this course. Students from the UK were able to apply for the games program as an extracurricular activity.

Following the model depicted in Fig. 1, two introductory sessions were held as part of the team forming stage, to introduce the participating students to each other, introduce the game topics, and suggest collaboration and communication tools. In addition, a Google group for questions and communication was set up. We introduced different subjects for games to be built, such as biology, law, holidays, or similar. The students were then able to choose a topic they found interesting. After that, they were asked to form international groups with group sizes 5-6 (2-3 from each country).

This was the starting point for stage 2, the idea finding & design stage. After forming groups, they started working on an initial game idea and a first game design. Two meetings with the instructors were organized, who supervised the design phase and commented on the ideas.

Stage 3 was organized as an on-site game jam event in London. The students were finally able to meet in person and to develop their games in a three-day on-site jam event. On the last day, they presented their games to a jury. The starting point of the game jam was an initial introduction of the jamming infrastructure. Next, every group of students (who already knew each other due to the remote collaboration) could choose a working space at the UK University. During the jam days, students had the possibility to work together on their projects from 09:00 to 21:00. Every day, the instructors paid a brief visit to each group to discuss the current stage and potential design and development issues. On the final day of the jam, all student groups presented their outcomes.

3.3 Material and Methods

To evaluate this learning design model, we conducted an initial small-scale trail of the proposed learning experience with 12 computer science students from an Austrian University and 12 students from a UK university, all from different disciplines (such as law, biology, or design). In order to learn from and improve our first attempt, the research scope has been defined broadly:

- Evaluate students' attitudes towards the international setup and the collaboration
- Evaluate students' experience with the group forming process
- Evaluate students' communication and collaboration methods
- Evaluate students' opinion on how such an activity contributes to their career
- Analyze their learning progress and their engagement

Thus, after the experience, we organized a final survey consisting of about 20 open-ended questions, which included organizational aspects, and questions focusing on answering the research scope mentioned above. The survey took approximately 15-20 minutes to complete.

4. FINDINGS

22 students, 12 students from an Austrian university and 10 from a UK university, participated in the final survey. In the following section, we will discuss the outcomes of the survey, focusing on the main objectives.

4.1 The Experience

In the following section we describe the students' experiences with the format based on their answers from the survey.

Experiences with the international student collaboration program

All 22 students participating in the survey would recommend such a learning experience format and 21 (95.95%) would participate in a similar course again. Asking the students what they liked in this format, many mentioned the international and collaborative format: *"Collaborating with international students was very*

interesting and stimulating", "It was wonderful to learn about communicating and working with people from a different culture as a team."

Experiences with the group forming process

Students had different experiences with the group forming process. While students were satisfied with the topics (*"Convenient, because broad categories were suggested and it was easy to find a team with similar interests"*) some students mentioned that it could be improved by adding further selection aspects to the process: *"the group forming was fine; could be better divided for number, specialization and student-year"*

Experiencing the remote communication & collaboration

Many teams had minor issues with remote communication and collaboration in the beginning phase, while other teams had a very good experience with their tools: *"It's pretty difficult to have proper online communication if the boundaries aren't set", "Communication was pretty good considering the geographical element and people's own commitments"*. For communication tools, students recommend using Google+ groups, newsgroups, Facebook groups, or instant messaging with videos or audio (skype, WhatsApp). For collaboration students mainly recommend Git, SVN, Google Drive, and/or Dropbox. For project management, some groups used Asana.

Experiencing the importance to their career

Asking the students how they would judge the importance of this program for their future career 15/21 (71.43%) fully agreed and mentioned different skills they learned, which they find important for their careers. Many comments included the collaboration in an international team as such a skill: *"Yes, because you learn about the difficulties of international collaboration and how to get over them", "Yes, as in this industry this is the kind of collaboration that would be carried out professionally", "Yes, working with a diverse team (different study programs) and remote communication was interesting", "Yes, building a project like this will be useful for the future, working in a team, online communication[…]", "It was fun, educational and important for developing a range of skills to boost employability"*. Students also mentioned the potential of this course to raise their awareness of career possibilities in other countries. *"You learn about opportunities and chances in other countries"*.

Learning progress

Most students mentioned their improved skills in working as a team, in remote collaboration, game development, and also new technical skills such as coding, or the use of different tools. Most students groups used Unity3D as a game engine. Thus, the CS students were able to improve their programming skills in C#, but also their 3D modeling skills in Blender. The outcomes are discussed in the next section.

4.2 Outcomes

Five games were developed during this program. From the instructors' perspective, the outcomes were extraordinary innovative and interesting. Many groups picked topics for games from their specific field (e.g. law or biology) and added new and interesting design aspects to the game. Figure 2 displays a puzzle element added by a group to their game inspired by the design of BioBrick (DNA sequences) structures, which influence the player and his abilities. Figure 3 illustrates a stealth game where the goal is to steal specific objects. Every crime is recorded and, if the player is caught, all the crimes and the time the player has to spend in prison are listed according to real UK law.

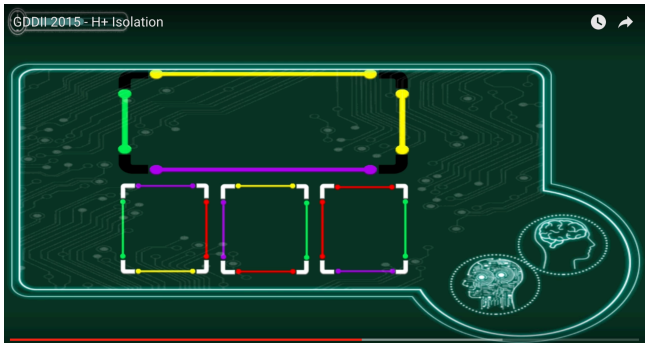

Figure 2. Puzzle game with bioengineering context inspired by DNA sequences

Figure 3. Game with law input summarizing the crimes committed in the game referring to real UK law

4.3 Challenges and Solutions

While the program was extremely well received, there is room for many aspects to be improved. Several students mentioned that they would like to get more support, tips, and feedback during the on-site jam event. One student suggested inter-team testing and feedback rounds to improve their game: "*More support to point out weaknesses and giving tips for improving the project*". Some students mentioned time issues and would suggest longer on-site jams (4-5 days).

Based on the recommendations of the students, we are currently developing an updated version of this program. We are planning to add two on-site jams. So students would meet in the beginning phase of the program to find teams, create first ideas and a first design. After that, they can work remotely on their projects. In a final jam, they can finalize their game projects, again on-site. This also gives all students the possibility to get to know the two different universities and cities. This is a valuable point, which can make the entire experience more attractive to both student groups.

Another point and potential obstacle to consider when implementing similar programs is definitely the budget necessary to support such an exchange. This exchange was partly supported by the international office at the university in order to provide students with grants to travel to the UK. Costs would be even higher, when implementing a program with two travelling partner universities. In a future experiment, it would be interesting to design a similar program using remote collaboration only and to compare the results with this study to see if similar positive results can be reached.

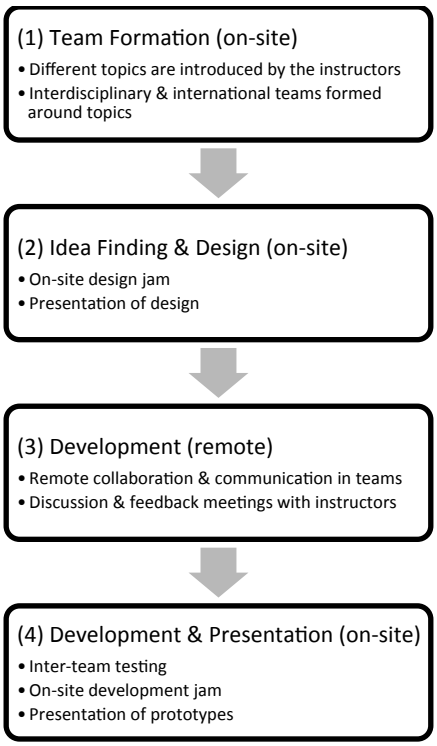

Figure 4 –Updated stages of the interdisciplinary and international game program

5. CONCLUSION

In this paper, we have presented an international and interdisciplinary project-based game development learning experience with the aim of creating a learning format to engage students studying different subjects, developing games together in an international setting. In an initial pilot we evaluated the students' experience with this program and their learning progress. Findings revealed that students are highly engaged by this program, and experience this program as a possibility to "boost employability". In addition to game development skills, they also learned how to work in international and interdisciplinary teams as well as how to work remotely in such teams.

Based on the results of our pilot, we were able to make several recommendations for future similar courses; in particular, the on-site jams should be longer. In a next iteration, we will design the program to have two on-site jams, one for the initial team-building and design phase and a second for the final game development. This gives students more time to work on their games, makes the meeting and group building more personal and gives all students the possibility to visit the two different countries.

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6. REFERENCES

[1] Overmars, M. 2004. Teaching computer science through game design. *Computer*, *37*(4), 81-83.

[2] Feldgen, M., and Clúa, O. 2004. Games as a motivation for freshman students learn programming. In *Frontiers in Education, 2004. FIE 2004. 34th Annual* (pp. S1H-11). IEEE.

[3] El-Nasr, M. S., and Smith, B. K. 2006. Learning through game modding. *Computers in Entertainment (CIE)*, *4*(1), 7.

[4] Kurkovsky, S. 2009. Engaging students through mobile game development. In *ACM SIGCSE Bulletin* (Vol. 41, No. 1, pp. 44-48). ACM.

[5] Kamen, M., 2014. Assasin's Creed historian on merging the past with fiction. In Wired.co.uk. Retrieved January 17, 2016. http://www.wired.co.uk/news/archive/2014-10/23/assassins-creed-unity-interview-maxime-durand

[6] Bayliss, J. D., and Strout, S. 2006. *Games as a Flavor of CS1* (Vol. 38, No. 1, pp. 500-504). ACM.

[7] Blumenfeld, P. C., Soloway, E., Marx, R. W., Krajcik, J. S., Guzdial, M., and Palincsar, A. 1991. Motivating project-based learning: Sustaining the doing, supporting the learning. *Educational psychologist*, *26*(3-4), 369-398.

[8] Davenport, D. 2000. Experience using a project-based approach in an introductory programming course. *Education, IEEE Transactions on*, *43*(4), 443-448.

[9] Leutenegger, S., and Edgington, J. 2007. A games first approach to teaching introductory programming. *ACM SIGCSE Bulletin*, *39*(1), 115-118.

[10] Köse, U. 2010. A web based system for project-based learning activities in "web design and programming" course. *Procedia-Social and Behavioral Sciences*, *2*(2), 1174-1184.

[11] Robertson, J., and Howells, C. 2008. Computer game design: Opportunities for successful learning. *Computers & Education*, *50*(2), 559-578.

[12] Preston, J. A., Chastine, J., O'Donnell, C., Tseng, T., and MacIntyre, B. 2012. Game jams: Community, motivations, and learning among jammers. *International Journal of Game-Based Learning (IJGBL)*, *2*(3), 51-70.

[13] Arya, A., Chastine, J., Preston, J., and Fowler, A. 2013. An international study on learning and process choices in the global game jam. *International Journal of Game-Based Learning (IJGBL)*, *3*(4), 27-46.

[14] Fowler, A., Khosmood, F., and Arya, A. 2013. The evolution and significance of the Global Game Jam. In *Proc. of the Foundations of Digital Games Conference 2013*.

[15] Fowler, A., Khosmood, F., Arya, A., and Lai, G. 2013. The global game jam for teaching and learning. In *Proceedings of the 4th Annual Conference on Computing and Information Technology Research and Education New Zealand* (pp. 28-34).

[16] Reng, L., Schoenau-Fog, H., and Kofoed, L. B. (2013). The motivational power of game communities-engaged through game jamming. In *Proceedings of the 8th International Conference on the Foundations of Digital Games*.

[17] Pirker, J. and Voll, K. 2015. Group Forming Processes – Experiences and Best Practice from Different Game Jams. Proceedings of the 2015 Workshop on Game Jams, Hackathons and Game Creation Events (Co-located with FDG2015).

[18] Entertainment Software Association. (2015). 2015 - Essential facts about the computer and video game industry. *Retrieved January*, *17*, 2016. http://www.theesa.com/wp-content/uploads/2015/04/ESA-Essential-Facts-2015.pdf