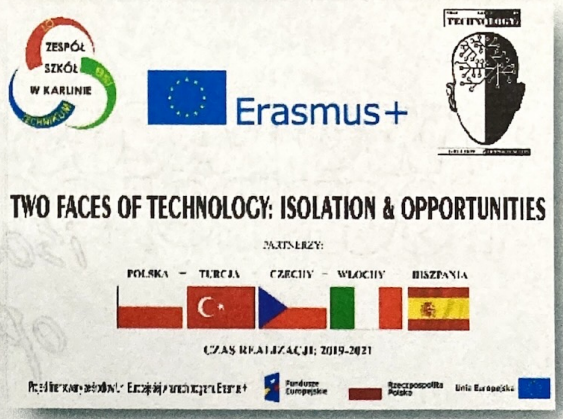
TWO FACES OF TECHNOLOGY

isolation and opportunites

SCHOOL GRAPHICAL PROGRAM

School graphical program based on Regulation of the Educational Minister from 30 January 2018 (Dz.U. z 2018 r., poz. 467)



- *Rozporządzenie Ministra Edukacji Narodowej z dnia 30 stycznia 2018 r. w sprawie podstawy programowej kształcenia ogólnego dla liceum ogólnokształcącego, technikum oraz branżowej szkoły II stopnia (Dz.U. z 2018 r., poz. 467)*
- *Załączniki nr 4 i 5do rozporządzenia Ministra Edukacji Narodowej z dnia 3 kwietnia 2019 r. w sprawie ramowych planów nauczania dla publicznych szkół(Dz.U. z 2019r., poz. 639)*

The contents of the program:

The author of the program and a teacher conducted the course:

mgr Renata Piszak-Walczykowska

I Introduction

Nowadays, the area of computer graphics is widely used in a variety of applications for specific purposes. We can find information about virtual simulators for training in driving vehicles, like cars, buses or trains; 3D representation of future buildings or houses most of the times only with the objective of visualization; computer and console games with high-quality graphics, where the player can live a different experience inside the virtual world; or film scenes and characters that are generated using computer graphics. Simulation, training, visualization and entertainment are environments where the use of computer graphics is very popular.

In this context, the possibilities of using computer graphics applications for education are opening an important research area. The technology is every day nearer to children, not only at home but also at school. There are many school 's subjects only related to technology and there is a common interest in all schools to introduce new computer-based programs and applications, for teaching specific concepts included in the school curriculum. The idea of creating useful applications for teaching and training some concepts (such as academic, social or communicative skills) seems to be of interest to all associations and special schools. There are efforts to describe the characteristics and possibilities of the use of new technologies (TIC) in the education of students who are very good at computer games and programs.

This program is based on the idea of using new technologies, in our case, computer graphics applications, for students who want to know more and more about graphical subjects. The aim of the program is to promote the use of computer graphics, create some tools for teachers and professionals in the educational process and motivate them to create and code new programs, applications, games and virtual reality in the future.

The program takes into the consideration the fact, that student's play evolves from simple manipulation of immediate reality to include more and more issues of a symbolic nature. As an example, at the beginning, the children start playing functionally with realistic toys and later start to make imaginary substitutions of some objects for others. Pretence itself offers a framework for the children to become familiarized with non-literal language but with special technical words, which will be used later during coding new programs and applications.

II Description of the course

Teaching Computer Graphics has been evolving, over the years, from more classical approaches to very advanced ones, what causes that teaching this subject is complex due to the broad range of skills required, from basic programming skills to mathematics, physics or problem-solving, and a visual assessment component. Three main issues have been mentioned here as very important for students: insufficient skills or competencies in mathematics, programming, and spatial thinking and reasoning. When students are aware of it, it is easier to start some activities, because our classes will focus on learning graphics terms, some theory of how graphics tools work, and common graphics creation tools similar to Gimp, Adobe Photoshop Adobe Flash, Correll, Adobe Dreamweaver and other new programs and applications used in our computers and mobile phones. Students are required to create a brand for themselves, a group, a project, a company or an organization that they select in the future. Inside of that brand, students create a logo of the project they start, a brochure promoting the school and some activities they are involved, vignettes of the pictures made by students during the tasks, a project of a card for students who cames to our school, a poster promoting the school, some graphic presentation and a website. Students learn the theory behind the graphics tools and learn how to use various tools to create the visual images to communicate a brand that they are interested in. Sample projects that students will create will be shown as well as a result of each activity that had been planned earlier.

Consequently, the teaching of Computer Graphic focuses on programming toolkits, where students can develop the 3D graphics and other subject like rendering, modeling, geometric transformations, curves, solid meshes, shaders and many other topics, with practical applications, through the implementation and evaluation of algorithms discussed in classes. The second part of the course will be practical and it will be based on the knowledge learnt earlier.

Computer Graphics is continually changed what demands from both the teacher and the student creative thinking and quick problem solving to use it in the work and private live. During the Computer Graphics lessons, students will learn effective graphic design skills using traditional and digital tools, materials and procedures used in the communication arts industry. They will be learnt the theory and function of the Adobe Creative Cloud, design principles, and digital photography used in the visual arts field. The focus will be on finding creative visual solutions to

communication problems using technical skills. This program will prepare students to the creative job market. Thanks to the knowledge learnt during the course – students can have some related careers as an app designer, web designer, graphic designer, illustrator or photographer. Students will take a part in some additional lessons during which they will have some opportunities to create a lot of new things like logo, brochures, leaflets, advertisements, commercials, invitations, buissness cards, posters, blogs, websites, and some exhibitions promoting the school and the project which they will take part. During the lessons - we will discuss some challenges, methodologies, and approaches for teaching Computer Graphics courses in a different context and tasks made to do. Following this strategy, practical classes are focused on the knowledge which is synchronized with theoretical classes and start with:

a) a short revision of newly lectured concepts; followed by a new material,

b) a detailed presentation and discussion of how the concepts are put to practice,

c) proceed with the application of knowledge into one of the course practical projects.

Our classes will start from considering the benefits and drawbacks of having the software projects which will be performed individually and in small groups of students. The aim of it is developing among the students soft skills such as teamwork, communication, creativity, effectiveness and proper use of distributed software development tools; and involving new challenges regarding assessment.

Theoretical component focuses on core topics: *geometric transformations* (2D/ 3D), *3D image synthesis* (local/global lighting; smooth shading, texturing; visibility calculation, shadows projection), *colour representation* (color perception; color representation models), *modeling* (3D meshes, curves, surfaces and solids), *graphical user interfaces, 2D Computer Graphics* (rasterization of lines and regions), and *shader programming*. Theoretical classes start with a presentation of the topics, with practical examples. Students participate on particular topics and challenges, and ask questions. The class content will be shared and the students can follow up and discuss topics. The theoretical component assessment consists of two mini-tests and a final written practical exam. The mini-tests include automated correction, and follow a mix of multiple-choice or true/false questions and questions with numeric answers (e.g. computing color conversions).

The final exam consists of a written test with both some problem-solving questions focusing on e.g. lighting, transformations, rasterization, or rendering, and open-form questions regarding the features and advantages /disadvantages of all details.

Practical component is composed of a set of practical tasks of rising complexity carried out in groups of some students.The students have to follow simple instructions, experimenting with the interface or changing specific parts of the code. The idea is to let them experience and get a grasp of the visual effects caused by manipulating transformations, materials, or lights without having to "hard-code", and being able to see what is being done earlier. Gradually, the assignments become more goal-oriented, asking the students to achieve a given result without too much steps, but still with well-done expected results. This gradual complexity reaches the peak in the final assignment: a project, animation, and interaction, and in which they have the freedom to explore the techniques learned in previous assignments to create an animated and interactive 3D scene. The assignments are distributed as follow: (1) *Setup and basics*, (2) *Geometry & transformations*, (3) *Lighting and Materials*, (4) *Textures*, (5) *Shaders*, and (6) *Final Project*.

III. The subject matter of the classes

a) The workshops with robbots – where students can turn in the robbots from the bricks, put there some electrical parts and code them to force the robbots to work.

b) The conferences and lectures with professors – students take parts in the conferences devoted to technological programs and applications.

c) The workshops connected with the Internet and computer programs – Students will design some project and print them in 3 D printer.

d) Our project's works, competitions and exhibitions students show the results of their work.

The course include also some elements of an online teaching – during which all classes are provided online through many online meeting tools and applications. The lessons were shared on the screen and include a slides' presentations and a virtual whiteboard, used by teachers, in a form of a scheme or more practical examples. The students can write their questions in the chat, allowing the teacher to answer when most appropriate.

After the initial presentation of contents and demonstration of examples, followed by explanation of the topic and clarification of any doubts, each group use a new knowledge in the software project. During this time, teachers go through each student group to assess the work progress and answer project-specific questions. To support the practical classes. Discord platform is recommended to use as the main communication tool which prepare the necessary environment, with voice and text channels for each class and share channels for more open discussions in private groups.

The teacher can call each group to the voice channel to discuss some tasks or doubts or resolve some problems. Thanks to it, the students have access to quick assistance for issues and questions, even when the teacher is assisting other groups at the moment. This tool provides feedback, support and some control on the students' progress and involvement in the projects. Students get also know with Git platform, where they are familiarized with a base repositories to have a direct access to the source code for online support. The course will be based on some principles:

1. Two-stage approach: Use an initial first stage, more tutorial-based at first, oriented to small projects, to increase the students' autonomy. This gives them the basis for the second stage of assignments, fully project-oriented.
2. Project-Based Learning: Have the students develop projects integrating multiple concepts and components, giving them a broader perspective of their interconnection, grasp the importance of applying software development tools and techniques and also foster students autonomy.
3. Foster other software engineering skills: While teaching CG, stress general good practices of software development, such as code structuring and optimization, debugging techniques, documentation and distributed version control.
4. Foster peer exchange: Provide easy ways for the students to exchange their work, experiments, and data for other students to review and try, and to pose questions to the class. This fosters the communication between them, especially limited in a remote context, and provides a sense of collaboration among all who can help others.

IV The aims of the program

The aims:

- ❖ to encourage students to work actively;
- ❖ to cooperate with students;
- ❖ to motivate students to expand their hobby, knowledge and experience;

- ❖ to stimulate students imagination and creativity;
- ❖ to teach students to plan, decide and make some tasks;
- ❖ to develop ability to work in the group;
- ❖ to get know new programs and applications;
- ❖ to get know vocabulary connected with computer graphics, CMYK, RGB...
- ❖ to get know how to design and print in 3D.

V. Methods, techniques and forms

The main methods used during the lessons are activating methods like: brainstorming, projects' methods, educational games, team games, games of skill, competitions. What is more, we will use a lot of communicative and audio-visual methods, direct teaching, practical teaching, expository methods and debates. They will be supported by visual and demonstration

Forms and techniques:

- ❖ individual works, pair works, team works
- ❖ „brain-gym" tasks

The main technique will be learning by doing and we will use the degree of difficulty; connection the theory with the practice and regularity.

Materials and graphic training aids:

- ❖ films and presentions prepared by the students
- ❖ robbots designed, built and coded by the students
- ❖ software: Gimp, Inkscape, Photoshop, Photoshop, Scratch
- ❖ portable storage media, pendrives and discs
- ❖ 3D digital printer

One of the challenges is the choice of the supporting technologies to use in the assignments. Several factors are taken into consideration and include:

- ✓ student's age and level,
- ✓ techniques of teaching,
- ✓ up-to-date programs and applications,
- ✓ student and teacher's evaluation,

The second part of the course – focuses on developing the students' practical skills, from a Computer Graphics as well as a software development perspective. Classes have more advanced

topics and techniques, while bringing in concepts of system architecture, data structures, the evaluation of a practical project and up to two practical tests.

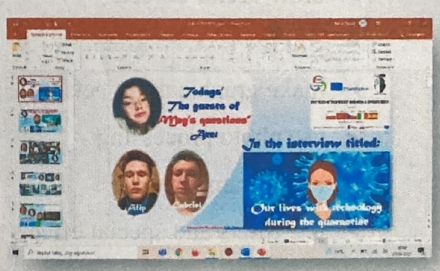
Theoretical component - the topics are (a) *scene graphs*, (b) *keyframe animation*, (c) *parametric surface modeling, 2D and 3D surfaces*, (d) *effects and shaders techniques*, (e) *direct scene interaction* and (f) *interoperability with other subsystems*. In addition, the presented topics are integrated with the components in an existing application.

Practical component - throughout the school year, students work in pairs on three projects, using the same technologies as earlier: (1) *Development of a scene graph renderer* (parser, data structures and data storage, scene graph renderer). (2) *Enhancement of techniques* used in the course (animations, surface modeling, effects and techniques using shaders). (3) *3D interface of a board game* (game element, state representation, functionalities and user interaction with communication among the players).

The diversity and complexity of the tasks in the first project, encourage the students to break down the project tasks into smaller exercises. The students focuses on scene rendering based on the concept of Scene Graph what allows for the usage of cameras, illumination and lights, among other scene attributes, as well as materials, textures, and the scene graph itself. Later, the groups simultaneously work on the parser and the renderer what encourages discussion and helps to find errors in each group's implementation.

The second project explores more advanced topics, integrated into the scene graph project, where an effect with shaders is visible: a "security camera" screen (on the bottom-right corner) using render-to-texture techniques and shaders that apply post-processing effects to the image.

For the third and final project, the students develop an interactive and animated 3D version of a board game whose AI code is implemented in the first project. The most important thing is that each work group has its own project where some students are required to implement new features such as interaction with the scene objects using the mouse, a game state machine to manage the game and rendering, and the interface with the module. The practical classes are used to code simple games and game components (gameboard and game pieces) which should be visible, as well as the interface.



Furthermore, there are two practical tests, after the first and second project. The test exercises are based on the project topics, such as the creation of the new effects using shaders. As these tests are performed individually, what they allow to evaluate the evolution of each student throughout each semester.

VI. Expected results and achievements

One of the most important feedback is done by the students by means of pedagogic questionnaires, which are applied after every course. For the specific purpose of the classes, a special questionnaire with 47 questions are addressed to all evaluated students taking part in the course. A Likert scale was used to assess the pedagogical effectiveness of each of the classes, with a scale from 1 (poor) to 5 (great), applied to the following questions:

Q1: Practical classes, theoretical presentation, and tools (Go Live, Shared Presentation)

Q2: Clarification of questions/problems with exercises during practical classes

Q3: Communication with teacher/monitor during practical classes

Q4: Clarification of questions/problems outside of class hours

Q5: Theoretical classes

Additionally, the questionnaire includes a question on what the students felt regarding understanding/following the classes' contents, and two open questions for additional remarks and suggestions for improvements in the future. What is more, the use of Discord and Git provide the required functionality as a feedback, and like other similar tools can be also used. It would be important to discuss these tools at a higher level with the programs' coordination and teachers from other courses. The use of these tools also provided additional analytics (such as the code contributions) to improve the students' assessment and for removing of difficulties. The feedback provided in these tools has benefits to improve the verbal feedback and can be further recalled by students and teachers.

After finishing the course, the students will get know how to:

- draw vector objects
- edit the text
- make graphical projects
- use photo processing
- make frame photos
- use filters and special effects
- code programs
- use operation systems: Linux, Windows lub Mac OS X

- create newspapers, logo, brochures, buissness cards, invitations, logo and signboards
- prepare project and print them in the 3 D digital printer

All students will be motivate to work and awarded by good grades which will be given for students final works and their involvement into the creation of them. Final evaluation will be made at the end of the course. Students will be observed during their work, competitions and exhibitions of their works. The teacher will also talk with students about the course and some difficulties which occured. The will analyse the problems and solve them together. The final evaluation will be the answer for the question connected with the aims of the courses and their realisation. Students will estimate the program, activities, methods, techniques and forms of the work, atractiveness and effectiveness of the program. The results of the evaluation will be read and taken into the consideration in the next classes.

VII. Conclusions

Teaching Computer Graphics is complex and must be kept up to date with current trends and technologies because of many changes which are not going to be completely reversed in the next few years. Computer Graphics carries additional specificities when compared with other software development courses, such as the setup, deployment, and execution of the projects with a 3D graphical component, and the importance of real-time visual assessment. The discussion of project details in the class is more effective, as well as for discussions among students. This stresses the importance of the cooperation between students and teachers and peer collaboration by means of project-based learning and communication tools such as Gimp, Correll, Illustrator, Power Point, Wordwall, Discord, Web and Git.

The development of graphic applications is addressed to students who would like to improve their knowledge and change the theory into practice. That is why, the program offers a wide set of advantages over conventional pedagogical methods. On the user's side, students show a special affinity towards computers; regarding the technology, It also offers a complete control over the environment presented, and facilitate abstract concepts, very difficult to represent in real world, to be explained to the user in a visual way. The tools presented in this program are good examples of this kind of applications, where technology meets education to improve the learning experience and, at the end, the quality of life of final users.

In the near future the teachers will end this software development and will face its testing using students, by assessing specific variables in order to validate the benefits of the virtual reality as an educational tool. I hope that use of this tool will show us new directions to aim towards

graphic educational work. As was mentioned before, one of this possible directions will lie in adding more social situations and empathic interaction between virtual characters and students in order to work in improving their social skills.

All works made during the courses are on the project webpage:

https://renkaw.wixsite.com/twofacesoftechnology

VIII Bibliography:

The literature

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3. T. Suselo, B.C. Wünsche, A. Luxton-Reilly *Technologies and tools to support teaching and learning computer graphics*: a literature review. Proceedings of the twenty-first Australasian computing education conference, ACE '19, Association for Computing Machinery, New York, NY, USA (2019), pp. 96-105, 10.1145/3286960.3286972
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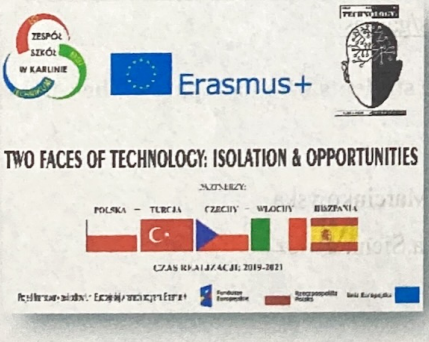
Internet websites and blogs

1. https://kahoot.com/welcomeback
2. https://quizlet.com/pl
3. http://www.edunation.com.pl
4. http://www.onestopenglish.com/teenagers/skills/games

The posters shown in the program were done by the students who took part in the course.

1. Poster – Martyna Bagińska
2. School table – Martyna Bagińska and Pola Marcinkowska
3. Ex Libris – Dominik Oleksik and Andżelika Sienkiewicz
4. Poster – Małgorzata Zep
5. Logo of the project – Wiktoria Centkowska
6. Picture from robbots workshops
7. Presentation – Małgorzata Zep, Filip Trela and Gabriel Marciniak
8. Presentation – Karolina Paszko and Małgorzata Zep
9. Poster – Pola Marcinkowska



Program was realised by

the group of students in

Zespół Szkół in Karlino

and it written as a part

of the Erasmus+

project at the tittle:

'Two Faces of technology. Isolation and opportunities.'

Karlino, 18.05.2022