Learning Computer Science at a Fair with an Escape Game

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Abstract. There exist several pedagogical devices to introduce computer science (CS) concepts to young pupils. No matter the resource used and the targeted age group, the learning can be done in an autonomous way with books or videos, at school with a teacher, during an event/fair with animators, etc. The challenge is always to keep the learner interested and involved with the activities. This paper presents how an *escape game* has been used to foster attendees of a fair to learn CS concepts. They were told a story in which they are locked in a strange bunker. To escape, they have to solve riddles needing basic understanding of CS concepts, such as binary numbers, text ciphering, or bubble sort algorithm, for example. Stands managed by animators allow the visitors to learn the CS concepts through interactive animations. Informal feedbacks from participants and stand animators were good.

Keywords: Escape Game · Computer Science Concepts · Fun learning

1 Introduction

Computer science (CS) concepts are not only taught to higher education students, but also to younger pupils [2,8]. Not all CS concepts can be taught to younger pupils, at least not in the same way than with higher education students. Specific pedagogical devices have been developed, focusing on computational thinking, digital literacy, etc. but they are not always easy to find, unless using a specialised digital library [4]. The *Computer Science and IT in Education ASBL* is a nonprofit organisation whose goal is to promote computer science at large. It regularly organises the *Computer Science Day* (CSDay), a fair where children and adults with no prior CS knowledge get the opportunity to be introduced to several CS concepts. The visitors of the fair can visit stands to learn CS concepts thanks to a team of animators, teaching them these concepts.

1.1 Related work

Particular pedagogical devices and resources must be selected to teach CS concepts to people without any CS background. For example, *CS Unplugged* activities [1] or the *Computer Science Field Guide* can be used to grow algorithmic thinking and encourage programming [5]. The place of learning is also important: it can be a classroom or other dedicated places, such as computer science fairs [7]. Such a place is perfect to allow its visitors to try different things at their own pace, following their own preferences. One challenge is to make sure that everyone gets the opportunity to take part to all the activities.

Using serious games to teach and learn CS concepts can be very effective, in particular for programming [9,3]. Learners enjoy playing game and are pushed to make progress and actively learn new things, if the design of the game is good. Also, the level of the game should be adapted to its audience, to not discourage its players. Finally, escape rooms and escape games provide challenging and motivating games. If well-designed, they can be used for educational purpose in the form of an escape classroom [6,10].

1.2 Motivation

This paper is about the *escape game* put in place during the CSDay 2019 fair to foster visitors to learn and be involved with the activities, in a fun and motivating way. Indeed, an observation made during the previous editions of the fair is that it was not easy to encourage its visitors to go through the different stands and animations. Just telling them to follow a route to learn several things was not motivating enough. Following the gamification process and taking advantage of the attractiveness of escape games resulted in a new way to organise a fair and

to naturally attract visitors to the stands, to teach them CS concepts, without computers, in a fun and challenging way and allowing them directly practice.

2 Escape Game Design

The visitors of the fair receive a sheet of paper with a story at the entrance, telling them they got stuck in a strange cave from which they want to escape! No timer, no pressure, they can collect and solve the riddles during all the day, knowing that the only constraint is to escape before the end of the fair.

The game takes place in several rooms, between which visitors were free to move. To help them solve the riddles, they had a log book they are receiving incrementally and clues they are collecting. To understand and interpret the clues, visitors should use some CS concepts. They can learn them hopping by a stand to ask an animator explain them. The riddle to solve is a pretext to learn a new concept, visitors are led where we want them to go.

2.1 Riddle

What kind of riddles do the visitors have to solve? For example, at some point in the game, visitors were directed towards an old computer in a hallway, whose keyboard was altered, some keys being highlighted. After a visit to the stand about data ciphering, where visitors can learn about the Cæsar cipher, they manage to find a meaningful word from the highlighted letters of the altered keyboard. How are the visitors helped? Words written in bold in the log book are used to attract their attention to guide them towards the riddle they have to work on or the stand they should visit to make progress. Another riddle is a drawing of a strange circle cut in six parts, with digits from 1 to 6 placed on these parts. Visitors have to find a number from this drawing, and must visit the algorithm stand to understand how to solve the riddle.

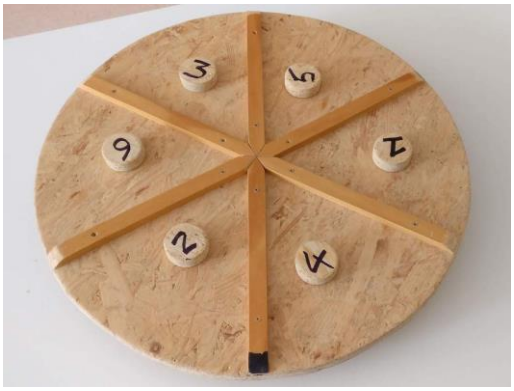

Fig. 1. A turntable is used during the fair to teach visitors the notion of algorithm and understand how a computer can sort numbers with the bubble sort algorithm.

2.2 Activity

What kind of activities are proposed? They are similar to CS Unplugged pen and paper activities to involve learners and to interactives from the Computer Science Field Guide to allow learners to experiment with the problem to solve. For example, visitors can understand the bubble sort algorithm thanks to a strange turntable with digits, shown on Figure 1. They have to follow instructions on a flowchart to manipulate it, and observe that the digits get sorted in ascending order. They can then make the link with the riddle with the drawing of a strange circle and understand that the number to guess is the number of loop iterations.

3 Conclusion

The escape game of the CSDay attracted more visitors to the event and to the activities organised during the fair. Visitors were happy and, in particular, the goal (a) to make them go through all the stands to learn CS concepts, (b) to be interested and involved in their learning by practicing and experimenting directly, (c) and to have a good time with a fun activity was clearly achieved. No formal survey about the game has been conducted yet, but informal feedbacks from the attendees show that the three objectives have been met. Some children refused to leave the fair until they solved all the riddles. Some participants to other events that took place during the fair told us that the escape game was an excellent idea to spend time between the other events.

Some drawbacks have also been observed. The level of difficulty of the escape game was not adapted to all the accepted age groups. A more guided path in the game should have been proposed for younger children. Also, the pedagogical device requires a lot of human resources the day of the fair. The team of the 2019 edition had 10 full-time people for the whole day, which was not enough.

To conclude, this first edition of the fair with an escape game, which managed to attract more than 34 persons and make them busy for a whole day learning CS concepts, was a big success. The combination of activities without computers, mixing the philosophies of the CS Unplugged and the Computer Science Field Guide activities with an escape game, fostered the learning of CS concepts thanks to the gamification process. Future improvements should include a multi-path story to better accommodate the different age groups and the design of new riddles and activities for uncovered CS concepts.

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Music Computer Technologies and Musical Informatics Training Course for Students

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Abstract. The beginning of the 21th century was marked by the introduction of computer and communication technologies in all spheres of human activity. Global changes have occurred in the way information is transmitted and presented. Digital technology has penetrated into music and music education. The achievements of sound recording, the technology of creating musical compositions combined with the new mass media possibilities have defined the previously non-existent areas of development and distribution of music, and require such knowledge that musicians who have received a classic music education do not have. The article describes the basic, which is devoted to development of actual theoretical and practical basis of raising knowledge of students at the music department with usage of music computer technologies.

Learning to play electronic musical instruments acquires a special relevance in the system of general music education at the school of the Digital Age, such an opportunity can also be provided in the system of additional education of students. Today in the class of electronic musical instruments it is necessary to meet the requirements of modern society in connection with the growing social demand for a higher level of professionalism, it is necessary to conduct a quality educational process and develop new, including digital technologies in the field of art. The discipline "Music Informatics", which is constantly evolving, since the mid-70s (IRCAM, France), is designed to solve a number of educational problems in this direction.

Keywords: Music Computer, Musical Informatics, Music Computer Technologies

1 Introduction

The development of a new approach to higher, vocational musical education has resulted from the need to solve the most acute problems in mass music pedagogy, including the current state of general music education. So, for example, at the annual International research and practical conference Contemporary Musical Education, held together by the Herzen State Pedagogical University of Russia and Saint Petersburg State Conservatory named after N. A. Rimsky-Korsakov from 2002 to 2019, musicologists, teachers of musical disciplines, researchers, teachers-practices noted that despite outstanding creative achievements, the possibilities of music education in mass pedagogy are not fully exploited and the teaching methods in the system of general music education do not change significantly.

One of the ways to solve this problem would be to find new educational technologies. They need to be improved by creating musical programs that would allow flexible and diversified use of the variety of rich pedagogical tools in teaching music and the huge possibilities of a music computer, contemporary music computer technologies (MCT).

Musical Iinformatics, in conjunction with other disciplines, helps integrate the modern musician in his or her professional activities. The purpose of the course of Musical Informatics is creating pre-conditions for expanding the professional capabilities of the musician with the use of modern digital technologies and facilitate the fuller use of the creative potential of the performer, composer or teacher of music.

The purpose of the subject is mastering music computer technologies, the software and hardware used in the professional activities of the musician and acquiring, by him or her, experience for working with digitized and synthesized sound and musical material in various formats as well as many other similar things.

2 The Discipline of *Musical Informatics* Includes the Following Sections:

The Introduction

The Subject of Musical Informatics

Music, Mathematics, Informatics: The Bounds of Their Interaction
Analysis as concerns harmony in works of music art and mathematical methods of their description.
Tentamen novae theoriae musicae ex certissimis harmoniae principiis delucide expositae (on the theory of music by L. Eller).
The descriptive-symbolic conception of music («Grammatica Speculativa» by Ch. S. Peirce and others).
On the characterization of various aspects of music creativity or "Musical Mathematics".
Musiques formelles by I. Xenakis.
Music programming.
Audio-visual synthesis.

Architectonics of Acoustic and Digital Musical Sound
Sound vibrations.
Musical sounds (fundamental tone, harmonics, notes).
The spectrum of sound.
The intensity and volume of sound.
Stereophonic parameters.
The modulation of high frequency vibrations.
The theory and practice of preserving sound.
Digital recording, the processing of sound and playback.

Musical Synthesizers
Extracts from the history of musical synthesizers.
Electronic musical instruments.
The musical instrument as synthesizer of musical sound.

Technologies of Sound Synthesis
The basic types of sound synthesis.
Sound filters: low-pass, hi-pass, band-pass, notch.
Equalizer.
Sound cards.
Audio mixing console.

Music Computer
Music computer: excerpts from history.
Computer modeling of music creative elements.
MIDI.
Music computer hardware.
Music computer software.
Music computer setting.
Music computer as the new multifunctional multi-timber musical instrument.
Music computer as the tool of teaching in the context of the basic methodological principles of the primary, secondary and higher additional professional and inclusive musical education.
Music computer as an instrument of the performer.

Digital Audio Workstation
The creation of a project, settings, the basics of working with an audio fragment.
The dynamic sound processing.
The frequency sound processing.
The spatial sound processing.
Reverberation.
Modulation effects.
Mixing and mastering of the musical project.

Digital Musical Synthesizer as a Modern Software-Hardware Complex for Teaching Musical Informatics
The modern digital musical synthesizer as part of the subject of music informatics.

Digital musical synthesizer: instrument controls.
Digital musical synthesizer as a means of performing music.

Professional Music Software
Audio editors.
Note editors.
Program music designers.
Automated musical arrangers.
Sequencers.
Teaching musical software.

On-line Music Teacher Assistance Services
A review of sheet music on-line software.
On-line audio editors.
Programs for microphone sound recording on-line.
Music studios.

Appendices
Appendix 1. A table of General MIDI instruments (GM)
Appendix 2. *Mathematical methods of research in musicology* course by M.S. Zalivadny
Appendix 3. Armenian universal analytical chart *AK-4* by V. Goshkovsky
Appendix 4. Examples of the use of matrix recording in analyses of music structures
Appendix 5. The examples of developing the original software by students participating in the Musical Informatics course: *MetronomKa* by A. Bungova and T. Bungov