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Development of Storytelling-Based Educational System Platforms for Educational Robotics Activities

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Abstract: This study concerns developing an educational system platform that supports Educational Robotics (ER) activities in elementary schools and is based on a storytelling teaching-strategy that provides abundant learning context. In this study, an educational system that accelerates the interactive learning activities of sharing and collaboration was developed. Teachers can use the developed platform to easily establish and operate an educational system that is suitable for the educational activities they wish to conduct. Regarding the students they can use the educational system to share the solutions to their tasks with their classmates and collaborate in order to make further progress. Additionally, the educational system was developed so that it can function on diverse IT devices such as smartphones which enhances its accessibility. Based on the evaluations of 10 teachers on the usability of the educational system along with its levels of operation, the results were shown to be positive.

Key words: Storytelling, educational robotics, programming, system platform, ER

INTRODUCTION

In the 21st century, the age of knowledge and information, the ability to effectively solve technical problems is required. To this end, many researchers are conducting studies on K-12 students using Educational Robotics (ER). The reason for the increase in the use of ER in education is the educational benefits it provides such as hands-on activities, learning by doing, cooperative learning, connecting with real-world problems and concrete and tangible learning activities (Bers *et al*., 2002; Portsmore and Rogers, 2004).

According to constructionism theory, knowledge is more effectively acquired through technological artifacts such as ER which are composed of self-directed activities than from a teacher delivering it directly to students. Such educational activities, involving someone constructing and assembling ER are appealing educational methods that assist the structuring of knowledge and stimulate the interest and curiosity of students. In fact, previous studies show that ER is effective in educational activities related to STEM and that it shows a potential impact on personal development including effective, perceptive and meta-perceptive aspects (Benitti, 2012). However, despite such basic educational benefits, tasks exist that must be addressed prior to successfully using ER.

First, there is the provision of abundant learning context for students' participation. There is a general tendency to believe that only the use of newly developed technological tools can improve the learning environment; however, it is difficult to create changes in the educational environment by simply using ER.

Therefore, we must consider not only the tech-centric approach but also the pedagogy of "how shall we teach?" Traditional teaching methods do not lead to meaningful learning because they concern segmental guidance of teaching content by dividing it into components and place a stronger emphasis on simple memorization. As the problem-solving activities of ER can foster active participation when provided with abundant learning context, the development of a useful mechanism is required.

Second, there is the establishment of an educational environment that promotes sharing and collaboration rather than competitive learning centered on competitions. In K-12, ER is mainly used for the purpose of robotic competitions. According to Nugent, robot competitions do not provide educational opportunities to acquire holistic knowledge of engineering design. Rao (2006) emphasized the fact that elementary school is an important phase in which to learn collaboration hence, robot competitions are not good practice. Although, robot competitions can motivate students and have many diverse advantages, an alternative approach that promotes an even better collaborative activity among the learners must be developed. Unlike the traditional classroom setting in which all students seek one correct

answer, ER activities allow many solutions to be developed for one problem. Therefore, establishing a learning environment where advice and professional knowledge can be shared between learners has great significance. With ER activities, we can consider developing supporting systems that promote sharing and collaboration in solving tasks and that reduce antagonism. If one solution to a problem is uploaded and shared, it is expected that other students will refer to the existing solution and develop an even better solution. As a result, this research has developed an educational system platform that uses storytelling as a means of supporting ER activities.

MATERIALS AND METHODS

Related works

Storytelling and ER: In storytelling activities, children think of images related to themselves and attempt to create a storyline that they find personally significant. This form of learning strategy provides the motivation that is required for students to acquire the knowledge and skills to achieve their goals. Additionally, from a teacher's methodological perspective, storytelling is known to promote active learning and reflective thinking and to increase motivation for and participation in learning. Therefore, it can be used as an effective educational strategy.

Even in ER, storytelling helps convey the learning content and provide a meaningful learning context. For example, the research by Williams *et al.* (2010) demonstrated that storytelling is the primary facet behind the capability to solve robotic challenges that are comprised of mathematical concepts such as distance, angles and rotation.

Also as a result of providing storytelling tasks that involve diverse or complicated problems or limitations, it allowed learners to actively design and develop solutions.

Storytelling-based System for ER: The storytelling education-system for ER was developed by Lee and Sung (2011) and as a result of applying this system, it was found that as the learner's level of educational achievement in relation to knowledge of robots increased, interest in learning and level of concentration also increased. Uploading and downloading using a system that supports the sharing of user-created content is a form of knowledge exchange and could also help other learners that are commencing new projects. However, the educational systems were developed in order to support teacher-centered class operations which means that there was insufficient support for collaborations between learners and that they also faced difficulties in establishing individual systems for conducting creative classes.

Additionally, they only work on PCs which means that the teacher and students must sit in front of a computer in order to use the system. Therefore, the educational environment does not suit the dynamic feature of ER activities. Through such preliminary studies, we can see that storytelling in ER activities is an effective teaching strategy that provides meaningful learning context. Also, the development of a storytelling educational-system-platform is required in order to establish an educational system that easily supports sharing and collaboration in ER activities.

System design: This system involves the development of an educational system-platform based on storytelling and it is designed as shown in Fig. 1.

The teacher can take the platform source materials and build their own system through the uploading process using the FTP Software on their own web server. The platform is composed primarily of the teachers' module and learners' module.

If an educational system is established on a platform, teachers and students are directed to different pages after signing in. The module process for teachers is shown in Fig. 2. After thinking of a new story project, the teachers can set and publish the rules that are required to solve the challenging tasks. They can also modify or reuse previous projects.

The learners can select a story project that interests them along with a task to solve and then upload their solution, evaluate their friend's solutions or enter feedback for revision.

They can also view solutions created and shared by others and reuse good ideas. Additionally, they can be provided with the learning opportunity to collaborate and devise solutions for challenging tasks (Fig. 3).

System implementation: The educational system this study aims to develop will be created using HTML5 and PHP, allowing it to be used on diverse devices such as computers, tablets and smartphones as shown in Fig. 4.

When a teacher is creating a story project and teaching materials, the problem of being limited to the learning environment in the immediate vicinity of the PC was solved by the students being able to use diverse devices such as smartphones to upload solutions. In particular, smartphones' interlocking camera function can

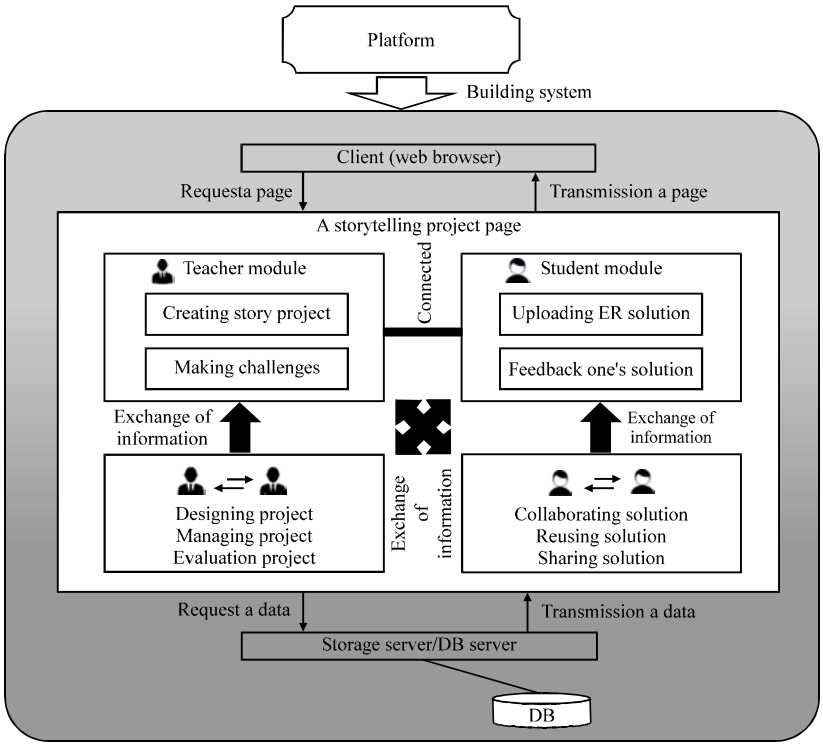

Fig. 1: Design of the educational system

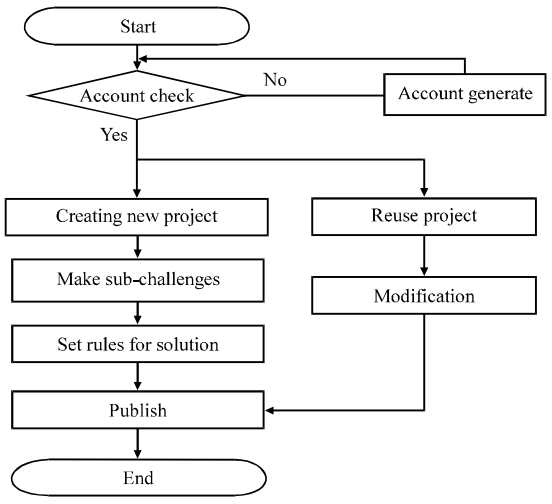

Fig. 2: Teacher module process

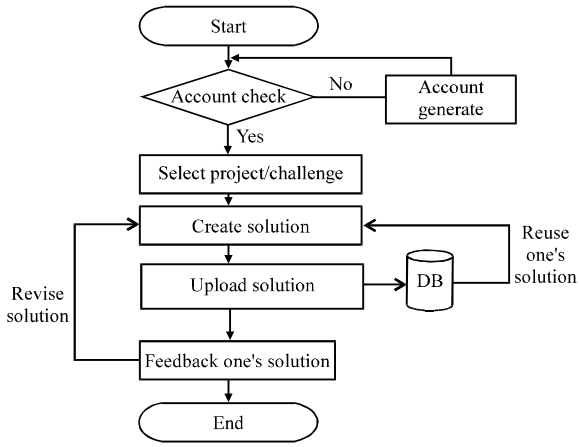

Fig. 3: Student learning process

accelerate immediate sharing and interactive feedback. The feedback and uploads in the educational system are based on video-clip materials coded in mp4 format which are supported by smart devices.

Figure 5 is a screen shot of the registration of a story topic in the project. When the storytelling project is created, it is depicted in the form of chessboard. It also introduces the project and includes details on the person

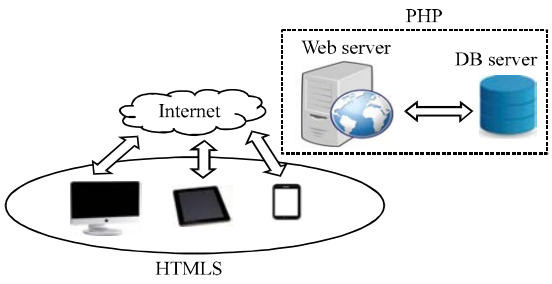

Fig. 4: Realization

Fig. 5: Content of a story project

Fig. 6: Registering projects

who uploaded it, the upload date and number of tasks. When each project is selected, the tasks to be handled are listed as shown in Fig. 6 and it is possible to upload a new task or modify or deletea task.

When a task is selected, the storytelling is then executed as shown in Fig. 7 and students can use ER to create solutions for problems and upload them. The solutions uploaded by students are displayed along with an image, the person who uploaded it, level of feedback and evaluation points.

Students can provide feedback to other students' solutions as shown in Fig. 8. Additionally, as a reusing concept they have the opportunity to share and create even better works or enhance their solutions based on their colleagues' feedback. The uploaded video is automatically compressed and saved in order to decrease the server load.

System evaluation: A user evaluation was conducted in order to examine the educational feasibility of the platform developed in this study. The participating subjects were 10 teachers who were conducting ER classes on-site.

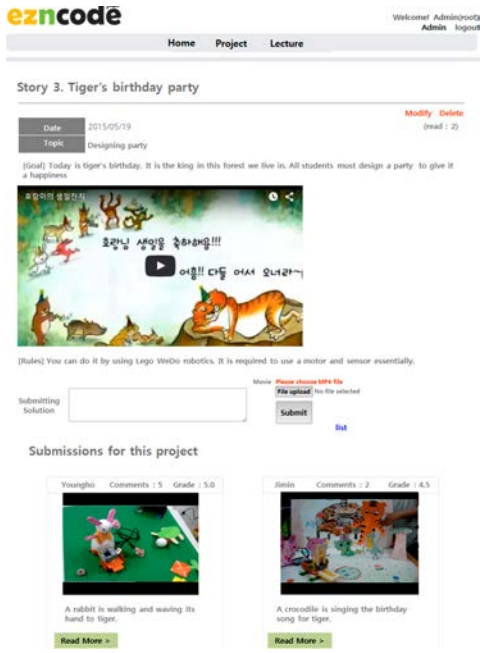

Fig. 7: List of solutions for project

Fig. 8: Registering feedback on solutions

After being introduced to the developed platform, they were then asked to establish and test an educational system and to provide their opinions using Likert 5-scale questionnaires.

RESULTS AND DISCUSSION

The evaluation categories were satisfactory level, usefulness and simplicity. The higher the points, the more positive the responses; the evaluation results are as shown in Table 1. The respondents mainly highlighted the need for improving the educational system by supplementing the LMS function. This is to be reflected in future development.

Table 1: Educational System evaluation results

Evaluation categories	Evaluation results
Satisfaction level	
Interface	4.7
Support forclass operation	4.8
Usefulness	
Value of educational use	4.6
Support for information sharing and collaboration	5.0
Compatibility between devices	5.0
Simplicity	
System establishment process	4.8
Uploading and revising projects	4.5
Managing lraners	4.0
Managing learning materials	4.3

CONCLUSION

This research concerns educational-system platform development for supporting ER educational activities in elementary schools. The platform is composed of storytelling-teaching strategies that provide abundant learning context and an educational system that accelerates the sharing and collaboration of learner interactions. By using the platform, teachers can easily establish and run educational systems for ER activities. Additionally, the learners can make use of the educational system, participate in a captivating storytelling task and improve their solutions by uploading an answer and interacting with their peers. This educational system is designed to operate on diverse devices including smartphones, in order to support dynamic ER activities. The developed platform received positive feedback from 10 current teachers after they had evaluated the usefulness of the system and its level of simplicity. The ER educational system can be easily established and operated through this platform so teachers can invest more time in the designing aspect of ER classes. Additionally, the learners can experience qualitative ER learning in a learning environment that promotes information sharing, collaboration and interaction. After conducting research on ER activities that use this system, a follow-up study on the effectiveness of this research will be conducted.

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