T. Hirashima et al. (Eds.) (2011). Proceedings of the 19th International Conference on Computers in Education. Chiang Mai, Thailand: Asia-Pacific Society for Computers in Education

Development of Virtual Exploratory Learning for Cyber Assistant Professor (CAP)

Hiroshi Matsuda, Yoshiaki Shindo
Computer and Information Engineering, Nippon Institute of Technology, Japan
hiroshi@nit.ac.jp

Abstract: We have developed the education system named CAP (Cyber Assistant Professor) which is an interactive e-Education system based on the 3D-CG animation and voice synthesis. Further, we have developed the animation scenario language named CPSL3 (Cyber Person Scenario Language 3) to reduce a production cost of teaching materials. These were not easy for some of students to get to the correct answer for lack of knowledge about scientific terms, electric parts or chemical materials. To improve this situation, we have developed the new function named Virtual Exploratory Learning (VEL) in CPSL3 Tag-commands. We have practiced the Virtual Science Experiment in the junior high school. This paper reports these results and effectiveness of our system.

Keywords: 3D Computer Graphics, e-Learning, Interactive Lecture

Introduction

Several types of science educational materials have been reported. [1] [2] [3] In Japan, one of the most representative science educational materials would be "Science Network" [4] produced by Japan Science and Technology Agency. Science Network has a lot of actual video libraries. On the other hand, the 3D computer graphics (3D-CG) animation using a virtual actor's speaking is very effective as an educational medium [5] [6]. But it usually takes long time to produce 3D-CG animations. "Jack" [7] was developed by Pennsylvania University, which was a LISP language SDK for military application. Alice [8] is a 3D graphics programming environment developed by Carnegie Mellon University. MPML [9] is a hypertext for the Web presenter developed by Tokyo University. TVML [10] is a script language that creates a real time CG animation of the news show automatically. However, as we have reported, [14] [16] these systems are not suitable for developments of teaching materials. To reduce the cost of producing 3D-CG educational contents and improve the capability of the educational system, we have developed e-Education system named Cyber Assistant Professor2 (CAP2) and the exclusive scenario language named Cyber Person Scenario Language 3(CPSL3) to write a scenario of 3D-CG animation. And we have developed the new function named Virtual Exploratory Learning (VEL) service in CAP2 system. This paper describes the summary of CAP2 and CPSL3, and then describes the detail of VEL service.

1. Cyber Assistant Professor (CAP)

We have developed e-Education system named Cyber Assistant Professor2 (CAP2). [11] [12] [13] [14] [15] [16] It includes Virtual Actor(s), 3D-CG Stage and many kinds of Stage Parts (3D-CG shaped models, photograph panels or text panels). Figure 1 shows the window of CAP2 e-Education system. To reduce the production cost of CAP2 animation and improve the capability of the

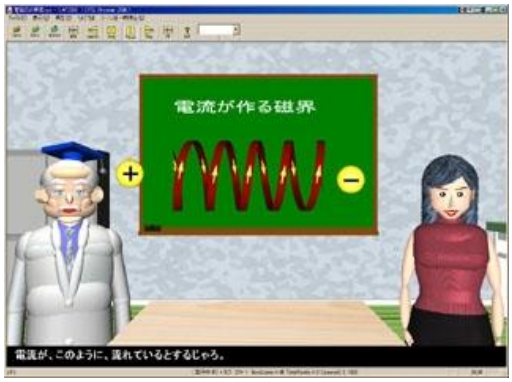


Figure 1 Cyber Assistant Professor 2

educational system, we have developed the exclusive script language named Cyber Person Scenario Language3 (CPSL3) [14] [16]. CPSL3 has more than 40 tags. CAP2 e-Education system converts CPSL3 scenario file to the real-time interactive 3D-CG animation. The detail of CPSL3 can be referred in References [11] [12] [13] [14] [15].

2. Virtual Exploratory Learning (VEL)

After we have tested the CAP2 education system in junior high school for three years, we have noticed that there would be some problems in our educational system. Although 3D-CG animation of Science Virtual Experiment has stimulated student's motivation and increased their interests, we cannot say their attained grade of Virtual Experiment to be very good. In the case of "Let's make the DC motor." 32% of students weren't able to design the working DC motor and in the case of "Let's create the typical Gas" more than 50% of students couldn't achieve the correct answer except the hydrogen gas creation. We thought that this situation might be caused for lack of knowledge of materials (electric parts or chemical materials.) in details. To improve these problems, it's necessary to give students the essential knowledge of materials before they begin to choose them in Virtual Experiment. However, there would be differences in necessary knowledge among students. To improve this problem, we have developed the **Virtual Exploratory Learning** (**VEL**), which inserts the VEL time period during the progress of experiment (named **VEL service**). In VEL service, each student can search for necessary knowledge like the explorer.

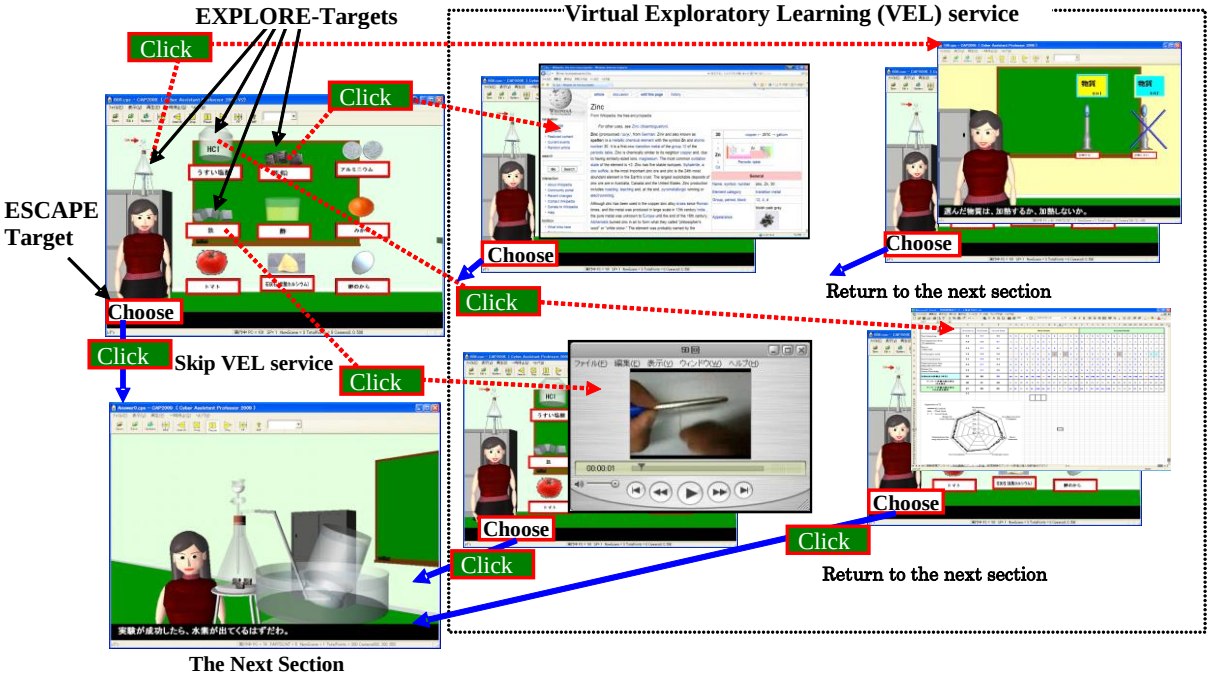


Figure 2 The flowchart of the student's operation in VEL service

Figure2 shows the flowchart of the student's operation during **VEL service**. Student can click **ESCAPE-Target** if he (she) doesn't need more knowledge of materials in details and get up to the next section of scenario. But if the student can't choose the correct answer cased by lack of knowledge of materials, he (she) can click any **EXPLORE-Target** to get the hint information inserted beforehand in the scenario. Explore Target is also Stage Parts (3D-CG shaped models, photograph panels or text panels) which can be defined by new CPSL3 Tag-Commands (See Table 1). We have developed 5 kinds of new target which are **ESCAPE-Target**, **INTERNET-Target**, **MOVIE-Target**, **EXPLAIN-Target** and **SHELL- Target**.

Table 1 New CPSL3 Tag-Commands for VEL service.

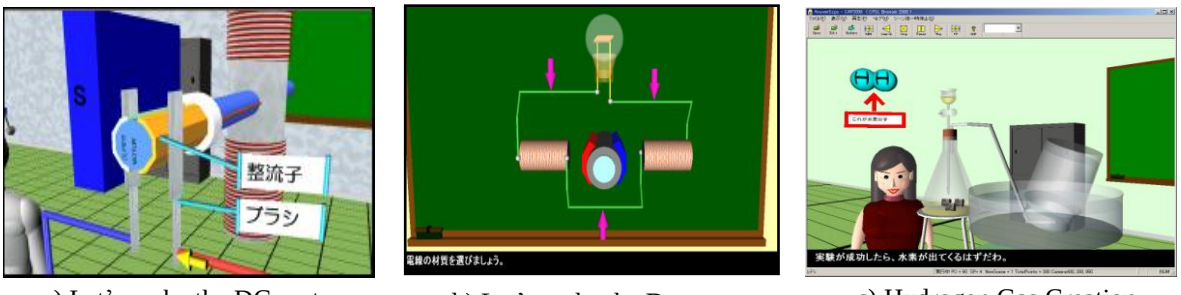
Tag Command	Function	Switch	
<EXPLORE>	Define the **ESCAPE-Target** to return to the animation scenario and enter the Virtual Exploratory Learning service.	FILE	Filename of Stage Parts of ESCAPE-Target.
		POSITION	Position coordinates of ESCAPE Target.
		ROTATION	Rotation of ESCAPE Target.
		SCALE	Scaling factor of ESCAPE Target.
<INTERNET>	Define the **INTERNET-Target** to open the specified WEB page.	FILE	Filename of Stage Parts of INTERNET Target.
		PARAM	URL or filename of WEB page.
		POSITION	Position coordinates of INTERNET-Target.
		ROTATION	Rotation of INTERNET-Target.
		SCALE	Scaling factor of INTERNET-Target.
<MPLAYER>	Define the **MOVIE-Target** to play the specified movie using the Media Player.	FILE	Filename of Stage Parts of MOVIE-Target.
		PARAM	Filename of movie file (AVI file).
		POSITION	Position coordinates of MOVIE-Target.
		ROTATION	Rotation of MOVIE-Target.
		SCALE	Scaling factor of MOVEI-Target.
<EXPLAIN>	Define the **EXPLAIN-Target** to execute another CAP2-Browser simultaneously.	FILE	Filename of Stage Parts of EXPLAIN-Target.
		PARAM	Filename of CPSL3 scenario file.
		POSITION	Position coordinates of EXPLAIN-Target.
		ROTATION	Rotations of EXPLAIN-Target.
		SCALE	Scaling factor of EXPLAIN-Target.
<SHELL>	Define the **SHELL-Target** to execute any kind of Windows application.	FILE	Filename of Stage Parts of SHELL-Target.
		PATH	Path name of Application file.
		COMMAND	Application file name.
		PARAM	Command parameter.(if necessary)
		POSITION	Position coordinates of SHELL-Target.
		ROTATION	Rotation of SHELL-Target.
		SCALE	Scaling factor SHELL-Target.

3. Virtual Science Experiment with VEL

In order to investigate the effect of Science Virtual Experiment with VEL service, we have developed science teaching materials for junior high school students based on the interactive 3D computer graphics animation with CAP2 education system. They are "Electric Circuit and Magnetic Force" and "Let's create the Gas". Science Virtual Experiment that includes 6 subjects. Table 3 shows the contents and Figure 3 are example pictures of Science Virtual Experiment.

Table 3 Contents of Science Virtual Experiment

Subject	Interactive Virtual Experiment
Electric Circuit and Magnetic Force	Let's make the DC motor.
	Let's make the Electric Dynamo.
Let's create the Gas.	Hydrogen Gas Creation.
	Carbon Dioxide Gas Creation.
	Oxygen Gas Creation.
	Ammonia Gas Creation.



a) Let's make the DC motor b) Let's make the Dynamo c) Hydrogen Gas Creation

Figure 3 Example pictures of Science Virtual Experiment

4. Results of Virtual Science Experiment

4.1 Rate of Correct answers in the Virtual Experiment

In order to investigate the VEL, 26 students tried to challenge the Virtual Experiment with VEL service, which were "Let's make the DC motor by choosing the electric parts." and "Let's create the typical Gas by choosing experimental equipments and chemical materials." After Virtual Experiment with VEL service, we have collected the logging data of choosing processes which were saved by CAP2 automatically. Figure 4 shows the results of "Let's make the DC motor". In this experiment, about **54%** students have used the VEL service. Among students who have used VEL service, the percentage of correct answers was from **56%** to **78%**. Conversely, among students who didn't use VEL service, the average percentage of correct answers was **48**%. Figure 5 shows the results of "Let's create the typical Gas". In this experiment, about **50**% students have used the VEL service. Among students who have used VEL service, the average percentage of correct answers was **62**%. Conversely, among students who didn't use VEL service, the average percentage of correct answers was **46**%.

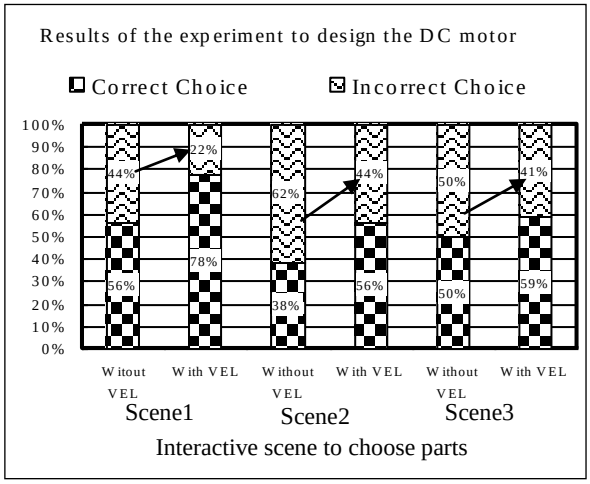


Figure 4 The case to design the DC motor

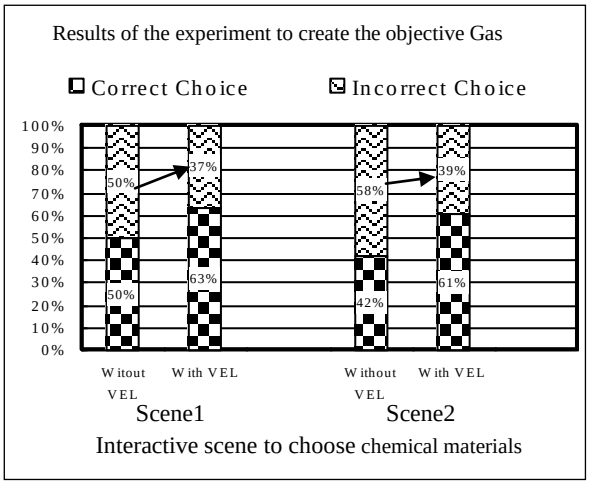


Figure 5 The case to create the objective Gas

4.2 Comparison result between VEL and non-VEL experiment

In order to investigate the effect of VEL service, Figure 6 shows the comparison result between the experiment with VEL and with one of non-VEL that we have done last year. The subject of the experiment was "Let's make the DC motor by choosing the electric parts." The percentage of students who were able to design high speed and middle speed motor has increased from **52%** to **68%**. And the percentage of "Failure" has decreased from **32%** to **16%**.

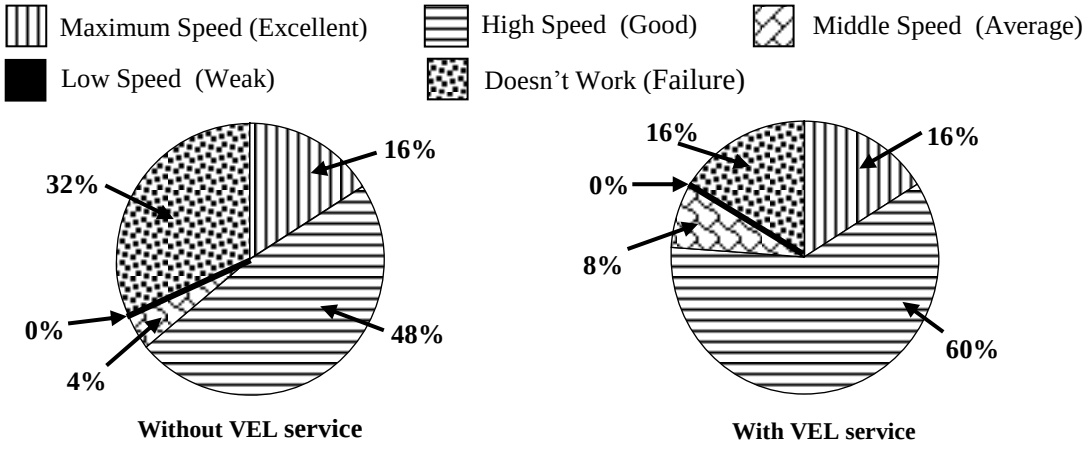


Figure 6 Comparison between results with VEL service and without VEL service

5. Conclusion

This paper described the summary of our e-Education system named **Cyber Assistant Professor 2** (**CAP2**) and **Cyber Person Scenario Language 3** (**CPSL3**) and the detail of **Virtual Exploratory Learning** (**VEL**) service which helps students in Virtual Science Experiment. And In order to investigate the effect of VEL service, we have developed the Science Virtual Science Experiment for junior high school students. Then we have analyzed the results of the logging data of choosing processes, which were saved by CAP2 automatically, in Virtual Experiment with VEL service. About **54%** students have used the VEL service and the percentage of correct answer has increased. It was just as we had expected that over half of students lacked the knowledge of experiment materials in details. Students were exploring various kinds of EXPLORE Target delightfully in VEL service. We were impressed that there was no student who looked confused and paused in front of the computer. And the impression of most of students was "**good**". From this point of view, we confirmed that the Science Virtual Experiment with VEL service is very effective for junior high school students.

Acknowledgements
This research was supported in part by Grant-in-Aid for Scientific Research from Japan ministry of Education, Culture, Sports, Science and Technology (No. 22500933).

References

[1] Towne, D.M., de Jong, T. and Spada, H. (Eds.): "Simulation-Based Experiential Learning", Springer-Verlag, Berlin, Heidelberg (1993)
[2] Forbus, K.D. and Feltovich, P.J. (Eds.): "Smart Machines in Education", AAAI Press (2001)
[3] Hirashima, T. et al.: "Error-Based Simulation to Promote Awareness of Errors in Elementary Mechanics and Its Evaluation", Proc. of AIED2009 (IOS Press), pp.409-416 (2009)
[4] http://www.rikanet.jst.go.jp/
[5] Arthur C. Graesser, Xiangen Hu,(2001), "Teaching with the Help of Talking Heads", Proceedings of IEEE International Conference on Advanced Learning Technology, pp.460-461.
[6] ssAmy L. Baylor, (2001), "Cognitive Requirements for Agent Based Learning Environments", Proceedings of IEEE International Conference on Advanced Learning Technology, pp.462-463.
[7] C. Phillips, N. I. Badler, (1988), "Jack: A toolkit for manipulating articulated figures", ACM/ SIGGRAPH Symposium on User Interface Software.
[8] Matthew Conway, Steve Audia, Dennis Cosgrove, Randy Pausch, (2000), "Alice: Lessons Learned from Building a 3D System for Novices", CHI 2000
[9] Tsutsui, M.Ishizuka, (2000), "A Multimodal Presentation Markup Language MPML with Controlling Functions of Character Agent." Journal of Information Processing Society of Japan, Vol.41, No.4.
[10] M.Hayashi, H.Ueda, T.Kurihara, M.Yasumura, (1999), "TVML (TV program Making Language)" Automatic TV Program Generation from Text-based Script", Proceedings of Imagina'99.
[11] H.Matsuda, Y.Shindo,(2009), "Development of e-Learning System which enables Virtual Science Experiment for Junior High School Students based on the Interactive 3D Computer Graphics Animation", Proceedings of The Educational Multimedia, Hypermedia and Telecommunications (ED-MEDIA2009), 2009
[12] H.Matsuda, Y.Shindo, (2008), "Virtual Chemical Experiment using Cyber Assistant Professor: CAP", Proceedings of The IEEE International Conference on Advanced Learning Technologies (ICALT2008), pp. 977-981
[13] Y.Shindo, H.Matsuda, (2007), "Virtual Experiment using Cyber Assistant Professor: CAP", Proceedings of The IEEE International Conference on Advanced Learning Technologies (ICALT2007), pp.865-869.
[14] H.Matsuda, Y.Shindo,(2006), "Education System Using Interactive 3D-CG Animation and Scenario Language for Teaching Materials.", Journal of Innovations in Education and Teaching International, Vol.43, No.2, pp.163-182.
[15] H.Matsuda, Y.Shindo, (2006), "Interactive Lecture using Cyber Assistant Professor: CAP", Proceedings of The IEEE International Conference on Advanced Learning Technologies (ICALT2006), pp. 629-633
[16] H.Matsuda, Y.Shindo,(2005), "Self e-Learning System Using Interactive Real-time 3D Computer Graphics Animations", The Journal of the Institute of Image Information and Television Engineers of Japan, Vol.59, No.11, pp.1659-1668.