

14. Function Development of Review on Learning for a Portable Hands-on Learning Support System

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○ Outline of study results

In the past we had worked on an observation learning support system with the help of the Grants-in-Aid for Scientific Research (Kakenhi for Young Scientists (B)), and this time, we improved the system and developed a function to enable students to review learning material at home. Based on a content access record in class, the system automatically creates content that can be viewed via the Internet for each student to review the learning material. We also developed a function that enables teachers to ascertain each student's access to such content.

Research field: Education information network

Category of Kakenhi: Science education and educational technology

Keyword: Teaching/learning support system

1. Background at the time of commencing the study

The observation learning support system that we had worked on operates with a contactless IC card and Personal Digital Assistant (PDA). Contactless IC cards had already been used widely for commuter passes and e-money, but studies on the methods to utilize them for an educational system had rarely been conducted.

In the meantime, part of the functions we were going to develop in this study had already been put into practical use in the form of a similar type of services. For example, the National Museum of Nature and Science in Tokyo was already providing services to record users' access to displayed information by using contactless IC cards and allow them to view such information again later via the Internet from outside. However, we aimed to also develop a function to enable teachers to ascertain what content each student viewed. Through this function, teachers would be able to provide students with proper guidance and the system was expected to work more effectively as an educational system.

2. Purpose of the study

This study aims to develop a portable hands-on learning support system with the following concrete functions, as well as to operate it and evaluate its effects.

- (1) A function to display, on a PDA, information on the advanced learning material that was collected from the IC chips attached to printed materials
- (2) A function to collect a learning record for each student and automatically create content for a personalized review of the learning material
- (3) A function to allow students to post their comments (evaluation and questions) on the material while reviewing what they have learned
- (4) A function to enable teachers to ascertain how each student utilizes the content for reviewing learning material

3. Method of the study

In FY2008, we designed a prototype of the system and conducted a preliminary evaluation. In FY2009, we made the final design of the system based on the results of the preliminary evaluation and conducted demonstrations. Throughout the study period, we asked for cooperation from teachers in Kumamoto prefecture and their opinions on system design and evaluation.

(1) FY2008

- (i) Development of a function to display, on a PDA, information on the advanced learning material that was collected from the IC chips attached to printed materials

IC chips attached to printed materials record information through a different method from that of contactless IC cards, so the conventional method could not be used. Therefore, we improved the system so that IC chips on printed materials could record information.

- (ii) Development of a function to collect a learning record for each student and automatically create personalized content for a personalized review of the learning material

We developed a function that transfers the personal learning record contained within a PDA to a database server on the Internet and, based upon this information, automatically creates review content for each student

- (iii) Development of a function to enable teachers to ascertain how each student utilizes the content for review (basic function)

We developed a function to ascertain the date and the frequency of access to the review content from various pieces of information on students' access to such content.

- (iv) Preliminary evaluation of the system

In order to verify whether the developed functions could really work as expected, we conducted a preliminary evaluation by listening to elementary school teachers' opinions and actually trying out

the system in class. Through this process, we repeated discussions with the Kumamoto Education Center staff and elementary school teachers in Kumamoto prefecture that had offered their cooperation for our system development so far.

(2) FY2009

- (i) Development of a function to allow students to post their comments (evaluation and questions) on the material while reviewing

We developed a function to allow students to post their comments on the learning material as they reviewed it. This function is designed to also be used for expanding the function mentioned in (ii) below, and is expected to contribute to the qualitative management of learning material by sending such information to the operations manager of the National Information Center for Educational Resources.

- (ii) Development of a function to enable teachers to ascertain how each student utilizes the content for reviewing the learning material (advanced function)

We developed a function to ascertain students' comments from various pieces of information on students' access to the content for review. This function is designed to work in line with the function to automatically create personalized learning content and to present teachers' responses to the comments that students posted.

- (iii) Demonstrations and system evaluation

We demonstrated the system at an elementary school in Kumamoto prefecture to obtain evaluations from students and teachers. We verified the effectiveness of this system based on these evaluations.

4. Study results

The tools we developed in this study had a function to display the content, a function to manage learning records, and a function to support review of the learning material for the portable hands-on learning support system.

- (1) A function to display the content

A learner, by holding the IC card on which his/her learning content is recorded (hereinafter referred to as a "content card") over the card reader/writer of a PDA, can have the learning content recorded in the content card displayed on the PDA screen. A moving image or other information that is too large to be recorded on a content card can be saved in the PDA, or the same content on

the Internet can be displayed by network connection.

In this system, a magnetic field is produced from a card reader/writer, and when a learner holds the IC card over it, the coil in the IC card receives a flux, which runs the IC chip in the IC card and thereby enables communication between the card reader/writer and the IC card.

We envision the following four types of usage for the portable hands-on learning support system, depending on the learning environment and learning content: learning by using a content card; learning by using data saved in a PDA; learning by using content available on the Internet as needed; and learning by using LOM content registered with the National Information Center for Educational Resources (NICER). However, the system is basically supposed to be used by holding a content card over the card reader/writer of a PDA.

(i) Learning by using a content card

Titles of 120 bytes and learning content of 240 bytes can be recorded in a content card. When holding a content card over the card reader/writer of a PDA, the titles and learning content recorded in the content card are displayed. Learning content that can be recorded in a content card can be viewed only with the portable hands-on learning support system, without taking a trouble to connect the PDA to the Internet.

(ii) Learning by using data saved in a PDA

Content cards can record only a limited amount of information, so they may sometimes be insufficient for a learner's needs. The system can also display content saved in a PDA in advance. Therefore, large volume content such as a moving image of around 100MB can also be used for learning so long as it can be displayed on a PDA screen. If using an SD memory card, an even larger content volume can also be available. When one holds a content card over the card reader/writer of a PDA, the titles and outlines of the content recorded in the content card are displayed, and when one clicks on the PDA screen, learning content saved in the PDA is displayed. A data pass to enter in the content card for accessing such data should be 208 bytes or less.

(iii) Learning by using content on the Internet

When a PDA is connected to the Internet via wireless LAN, content on the Internet can be displayed. When one holds a content card over the card reader/writer of a PDA, titles and outlines of the content recorded in the content card are displayed, and when one clicks on the PDA screen, learning content from the Internet set in advance is displayed. In this case, the same data pass as mentioned in (ii) above is also used for Internet addresses (URLs) of the content to be displayed, so URLs should be 208 bytes or less.

(iv) Learning by using content registered with the NICER

When a PDA is connected to the Internet via wireless LAN, content on the NICER website can be displayed. When one holds a content card over the card reader/writer of a PDA, titles and outlines of the content recorded in the content card are displayed, and when one clicks on the PDA screen, learning content on the NICER website is displayed. As URLs of NICER content contain unique IDs (LOM IDs) and may be over 208 bytes, we prepared a database on the NICER website that links LOM IDs to content IDs (8 bytes).

(2) A function to manage learning records

We incorporated a function into the portable hands-on learning support system to manage learning records. When and which content card each learner uses is recorded in the PDA and this shows his/her learning record. This tool is supposed to be used even outside of school, at a playground or other place where a network environment is hard to secure. Therefore, IDs on content cards and the date and time they were displayed on the PDA screen are recorded in the PDA. After studying, a learner is supposed to hold the IC card that contains his/her learning record (hereinafter referred to as a “learning record card”) over the card reader/writer of the PDA and thereby enter his/her learning record. When entering a learning record in this manner, if the PDA is connected to the network, the learning record is entered into the learning record card and at the same time is automatically sent to the NICER’s learning record management server.

(3) A function to support review of learning material

This function is roughly divided into one for learning support for learners and one for teaching support for teachers. The outline of each function and the overall structure are as follows.

(i) A function for learners

A learner can use this function by accessing the NICER website from his/her browser and thereby check any content he/she has viewed, not only at school but also at home and other places. By using this function, a learner can display a list of the content he/she has learned by date, and if he/she clicks a title on the list or a thumbnail, the same content as the one displayed on his/her portable hands-on learning support tool or on a PDA can be viewed on a PC. A learner can view the same content more than once, which will facilitate his/her review of the learning material.

This function also contains a feature to allow learners to post their findings and questions. If a learner pushes a Q&A button on the screen, an entry screen appears. Teachers respond to such findings and questions entered by learners and can lead them to deepen their learning.

In order to utilize this function, a learner needs to connect the PDA to the Internet via wireless

LAN after using the portable hands-on learning support tool. In this situation, the learning record saved in the PDA is automatically uploaded to NICER's server. The learner needs to go through the following procedures beforehand:

- Create an account in the support system for reviewing the learning material and set his/her ID.
- Enter the ID established upon the issuance of his/her account into his/her learning record card

Through these procedures, each learning record card can be tied to its respective learner.

(ii) A function for teachers

Teachers can ascertain how each learner uses the review function. When any findings or questions arising from the learning material are posted in the Q&A column, the receipt of a new comment is indicated on the screen. By clicking a learner's name, teachers can check when and which content he/she has viewed and on which content he/she has made a comment. They can enter their responses to the comment by clicking the relevant Q&A column. Teachers' responses are returned to respective learners and may lead them to deepen their learning.

In order to verify the effects of the function of managing learning records and a function to support the review of learning material for the portable hands-on learning support system, we conducted a practice lesson on "living organisms and their environment" for a fourth-grade science class.

We examined changes in students' awareness before and after a class utilizing the portable hands-on learning support tool by asking them to evaluate themselves in six areas on a scale of one to four (with one point as the most negative answer and four points as the most positive answer) and calculate the total points.

As a result, the points became significantly high after the class, particularly for questions concerning the daily observation of plants (e.g. "Do you think you often observe plants, flowers, and trees during breaks?" and "When questions arise while you are observing plants, flowers, and trees, do you try to solve them later?"), and questions concerning preference for science and nature observation (e.g. "Do you like observing plants and flowers at the playground and in the school yard?" and "Do you like observing trees at the playground and in the school yard?"). This outcome indicates the usefulness of PDAs in arousing students' interest and encouraging them to observe plants regularly.

5. Major academic works

(The author's name is underlined as a leader, co-researcher, or joint researcher)

[Scholarly journal paper] (Total: 1)

(i) Satoshi Enomoto, Tomohiro Yamamoto, Yasutaka Shimizu, “Utilization of PDAs for Mat Exercise in an Elementary School Physical Education Class and Its Evaluation,” *Japan Society for Educational Technology Journal*, with peer review, Vol. 32, Suppl. pp. 85-88

[Presentations at academic societies] (Total: 7)

(i) Yusuke Morita, Satoshi Enomoto, Tomohiro Yamamoto, “Practical Study of Portable Learning Assistance Tools using PDAs in an Elementary Science Field Activity,” *17th International Conference on Computers in Education*, pp.608-612

(ii) Satoshi Enomoto, Tomohiro Yamamoto, Yusuke Morita, Yasutaka Shimizu, “Practical Study of Geological Observations using Contactless IC Cards and PDAs in Elementary Science Field Activity and Its Evaluation,” *Papers for the 35th National Conference in Tsukuba*, the Japan Association for Educational Technology

(iii) Satoshi Enomoto, Tomohiro Yamamoto, “Development of Portable Learning Support Tool for Hands-on Learning with PDA and Contactless IC Card,” 3rd International Computer and Instructional Technologies Symposium

(iv) Satoshi Enomoto, Tomohiro Yamamoto, “Development of Portable Hands-on Learning Support System with Functions for Review on Learning,” *Speech Papers for the 25th National Conference, Japan Society for Educational Technology*, pp. 933-934

(v) Satoshi Enomoto, Tomohiro Yamamoto, “Basic Development of Portable Hands-on Learning Support System with Functions for Review on Learning,” *Technical Report for the Institute of Electronics, Information and Communication Engineers*, Vol. 108, No. 470, ET2008-125, pp.187-192

(vi) Yusuke Morita, Satoshi Enomoto, Tomohiro Yamamoto, Yasutaka Shimizu, “Practical Study of Portable Hands-on Learning Support System using PDAs and Its Evaluation,” *Technical Report for the Institute of Electronics, Information and Communication Engineers*, Vol. 108, No. 470, ET2008-126, pp.193-198

(vii) Satoshi Enomoto, Tomohiro Yamamoto, “Designing of Portable Hands-on Learning Support System with Functions for Review on Learning,” *Speech Papers for the 24th National Conference, Japan Society for Educational Technology*, pp. 425-426

6. Research organization

(1) Leader

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7. Reports on this study

“Report on Research Results under the Grants-in-Aid for Scientific Research” (April 23, 2010)

<http://kaken.nii.ac.jp/ja/p/20700657>