Next-generation Digital Educational Solutions for Use in the Classroom

● Hidehiko Mayumi

Fujitsu Network Solutions Limited has developed, through on-site research conducted jointly with participating schools, two next-generation digital educational solutions that address problems in elementary and secondary schools. One, called "Shu-Chu-Train," is a modular learning system that provides effective training for the prefrontal area of the brain and improves a student's ability to concentrate and retain information, skills that are critical to academic ability. The other, called "Manavication," is a system that supports collaborative learning. It dramatically speeds up communications between the teacher and students and among the students while supporting the development of thinking power, judgment, and expressive power. These two solutions are designed to be used with tablets so that they can be regularly used to maintain and improve fundamental knowledge and basic skills and support the development of collaborative problem-solving abilities. This paper introduces these next-generation digital educational solutions designed to support new learning appropriate for the 21st century.

1. Introduction

In Japan, new educational guidelines[1)] were established in April 2012 for all middle schools and the secondary education section in special needs schools. These guidelines call for a thorough acquisition of fundamental knowledge and basic skills, the fostering of creative thinking, decision-making ability, and self-expression, and the cultivation of life skills that help a student achieve a healthy balance among intellectual, moral, and physical qualities. At the same time, the digitization of education at schools is being promoted as a means of creating a form of learning appropriate for the 21st century. The establishment of computer rooms for students and the provision of personal computers for teachers and administrators are nearly complete at all schools in the country, and digitization of the ordinary classroom—the heart of public education—is finally underway. Most schools are already equipped with electronic whiteboards, and some teachers are conducting classes using digital textbooks.

Nevertheless, the information and communications technology (ICT) environments that are being created in the classroom are not being fully utilized—they are simply being used to provide descriptions and explanations that are easier to understand compared with those generally provided using conventional classroom facilities. The tendency has been to use ICT to help the teacher teach rather than to help the students learn. The focus should be on improving the students' abilities. Along with the continuing digitization of education will come a need for true solutions that help develop in children the skills needed to flourish in life.

This paper introduces a modular learning system called "Shu-Chu-Train" and a collaborative learning support system called "Manavication" developed by Fujitsu Network Solutions Ltd. through on-site research conducted jointly with participating schools. These digital educational solutions are aimed at the problems described and seek to develop the abilities of students in elementary and secondary schools through the use of ICT in the classroom environment. In particular, it describes the development background, system overview, effect of introduction, and remaining issues for each of these solutions.

2. Acquiring fundamental knowledge and basic skills

While there are a variety of skills and abilities that schools strive to develop in students, two types are focused on in this paper. One is fundamental knowledge and basic skills, and the other is collaborative problem solving.

The main objective of schools in public education is to maintain and improve a student's academic ability in an ongoing manner. However, the current situation in Japanese public schools is that personnel changes are unavoidable—most teachers change schools every five years. Under such conditions, a learning system independent of the leadership ability of individual teachers is needed to maintain and improve fundamental knowledge and basic skills in an ongoing manner despite changes in teachers and the school principal.[2)]

One effective means of maintaining and improving fundamental knowledge and basic skills is modular learning.[note 1)] This type of learning is a form of "brain training" that enhances a student's ability to concentrate and retain information, the foundation of academic ability. Brain training effectively exercises the brain's prefrontal area, which serves as a person's "command post," and improves concentration and retention, skills critical to academic ability, in a relatively short period of time. It also promotes the acquisition of fundamental knowledge. Any student can become actively engaged with brain training, and it has been scientifically shown that brain training—if faithfully continued—can extend one's power of concentration and power of retention.

In this way, a learning system that can reliably and firmly develop academic ability can be established.

3. Shu-Chu-Train digital educational solution

"Shu-Chu-Train" is an example of a digital educational solution for enhancing concentration and retention that was developed to achieve the learning system described in the previous section. The name is a portmanteau of "shuchu," the Japanese word for "concentration," and "train," which is short for "training," With this solution, the student uses a tablet or other device to input answers to a test by handwriting or by keyboard as fast and as accurately as possible. This process encourages the student to concentrate and exercises the prefrontal area of the student's brain, thereby enhancing fundamental knowledge and basic skills. Shu-Chu-Train presents five types of tests involving arithmetic, Japanese (character readings), English, social/natural sciences, and cognition/retention (**Figure 1**). Testing, under the supervision of Professor Ryuta Kawashima of Tohoku University, demonstrated that each type of test activates the brain's prefrontal area in a statistically significant way or generates a tendency toward activation.[note 2)]

In schools, this digital educational solution has been mainly used in the morning, before class begins. Statistical data obtained over a two-year period has shown that regular use of Shu-Chu-Train as a form of modular learning improves a student's ability to concentrate and retain information. The example results shown in **Figure 2** demonstrate that concentration was more likely to improve in a steady manner than retention, which is reasonable given that this solution serves mainly to improve one's ability to concentrate. Nevertheless, the positive effects of an enhanced ability to concentrate can have an effect in other areas, such as improving one's ability to retain information.[2)]

It has been predicted elsewhere that regular use of brain training can have a certain effect on concentration and retention. As shown in the study described here, concentration and retention each have correlation (or no correlation) with academic ability by viewpoint and with academic ability by subject. The values obtained for these two types of correlation are listed in **Table 1**, where a higher numerical value corresponds to a stronger correlation.

1) Correlation with academic ability by viewpoint

- Interest/motivation/attitude: correlation with concentration
- Thinking/judgment/expression: correlation with retention
- Skills: correlation with concentration and retention
- Knowledge/understanding: correlation with concentration

In short, correlation was found to exist between academic ability and either concentration or retention

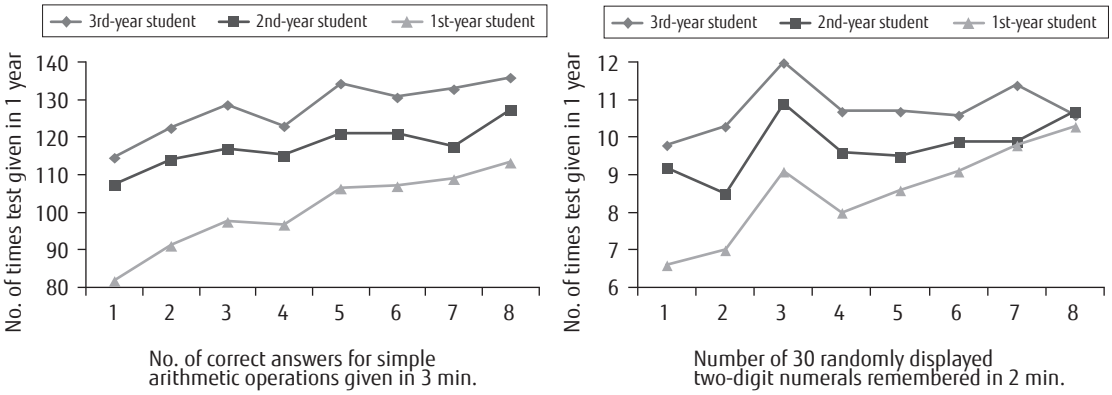
note 1) A learning format conducted in unit intervals such as 10 or 15 minutes.[3)]

note 2) Individual differences are present in brain activation.

(a) Arithmetic test

(b) Social/Natural sciences test

Figure 1
Screenshots of Shu-Chu-Train.



(a) Concentration: Results of arithmetic test

(b) Retention: Results of retention test

Figure 2
Shu-Chu-Train results (concentration/retention).

for all of the above viewpoints.

2) Correlation with academic ability by subject

- Japanese/English/mathematics: correlation with concentration
- Social/Natural sciences: weak correlation with concentration and retention

These results suggest that enhancing concentration and retention through brain training can build a foundation and provide support for the study of Japanese, English, and mathematics. However, a strong correlation could not be seen between academic ability in the social and natural sciences and concentration/retention. The reason for this is considered to be that interest/motivation/attitude with respect to subject content can affect academic ability, especially in the case of the social and natural sciences.[4)]

As described above, the regular use of brain training can have a definite effect. A brain-training boom began around 2005, and a number of schools

Table 1
Shu-Chu-Train effects.

4 Viewpoints	Concentration	Retention
Interest/motivation/attitude	0.40	0.32
Thinking/judgment/expression	0.38	0.42
Skills	0.46	0.40
Knowledge/understanding	0.40	0.31

Subject	Concentration	Retention
Japanese	0.41	0.29
Society	0.26	0.28
Math	0.46	0.35
Science	0.30	0.33
English	0.46	0.38

came to incorporate it in studies. However, there are almost no schools that are still applying it in an ongoing manner. The reason given for this is that brain training can be quite tedious and that students simply become bored with it. On the other hand, if students are given brain-training tests that are fun to take, the brain enters a relaxed state without activating the prefrontal area, so the desired effects are not obtained. There is therefore a need for some means that can motivate students to continue with brain training even if they find it tedious at times. One approach to raising student motivation with respect to daily tests would be to take the data, which is currently consolidated in on-site school servers, and centralize and manage it using a cloud service to provide motivating feedback in the form of statistical data.

4. Support for development of collaborative problem-solving abilities

Progress in incorporating ICT into the classroom is making it possible to provide fundamental iterative and individualized learning tailored to different levels, which has been difficult to achieve in the past. Improvements in basic academic ability can therefore be expected. However, there are concerns that the development of one's ability to interact with others within various types of groups through joint learning or collaborative learning will be neglected because of such ICT developments. At the same time, the proliferation of ICT devices such as mobile phones, personal computers, and game consoles in the environment that surrounds children today indicates a high level of information literacy. Nevertheless, interaction with others is decreasing due to the popularity of communication via the Internet, with the result that young people are becoming increasingly isolated. In addition, people are losing their ability to think logically, make accurate judgments, and express themselves freely.

There are consequently concerns that this dependency on ICT devices in school and in the home will bring about a dramatic drop in "collaborative problem-solving abilities," the development of which is important in elementary and secondary education. In fact, solving this problem is thought to be the biggest challenge facing public education in Japan today. It is being said that the Organization for Economic Co-operation and Development (OECD) will be adding collaborative problem-solving abilities as a new subject in its 2015 Program for International Student Assessment (PISA).

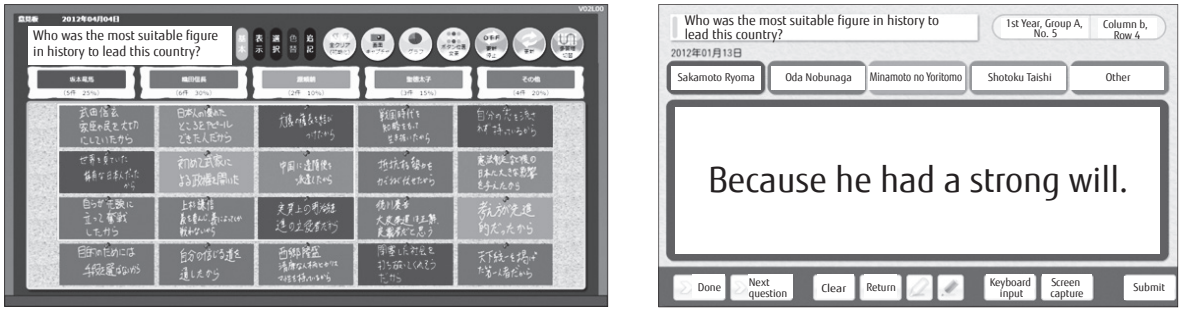
Having good collaborative problem-solving abilities means having the ability to look at things logically, to make accurate judgments, and to express one's opinions freely. In other words, developing good collaborative problem-solving abilities means developing the capacity for thinking, for making judgments, and for expressing oneself. One effective measure to this end would be to hold workshop-type classes centered about activities that take on insoluble societal problems in a creative manner through lively discussions among students. Workshop-type classes can result in substantial improvements in non-cognitive skills such as concern for social issues, curiosity about the unknown, and understanding others by having students exchange opinions and learn from each other.

5. Manavication digital educational solution

The "Manavication" digital educational solution enables the user to navigate through learning and communication. It was developed to support the type of collaborative learning described in the previous section (its name was derived from "manabi," the Japanese word for "learning," and the English word "communication"). It enables students to enter opinions or replies to a question on a tablet or other device. It also facilitates the creation of a forum for collaborative learning in which students notice and think about each other's opinions by posting and sharing them using an electronic whiteboard or similar tool (**Figure 3**). The Manavication solution was developed from the ground up through joint research with schools after hearing from teachers that they would like to use such a digital educational solution in the classroom. It began with the development of a prototype that the teachers were asked to use for all of their subjects. A cycle of observing how both students and teachers used and operated the solution and identifying ways to enhance it was then repeated. Other potential enhancements were identified through guest teaching.

Several specific subject units were targeted in this prototype evaluation:

- Japanese—the poem "Sunset" and its effects on



(a) Teacher screen

(b) Student screen

Figure 3
Screenshots of Manavication.

people/society

- Society—ancient Japan in East Asia
- Mathematics—simultaneous equations
- Science—the matter around us and its properties
- English—showing the way
- Fine arts—paper-cutting and emotions
- Music—Appreciation: Franz Shubert's "Erlkönig"
- Morals—self-development, etc.

Using Manavication in workshop-type classes contributed to the development of students' capacity for thinking, for making judgments, and for expressing themselves. Typical comments by students who used this solution in actual classes are summarized below.

- I self-reflected by expressing my opinions in writing (capacity for thinking).
- I broadened my range of thinking by seeing opinions different from my own (capacity for making judgments).
- I expressed my opinions in concise form given limited time and space (capacity for expressing oneself).

Teachers felt this change in students in the following ways.

- Students became accustomed to applying their capacity for thinking at all times, and their sense of classroom participation began to take root and grow.
- Students became aware of the diversity in each other's ideas and opinions, and a subsequent tendency toward cooperation could be seen.

An effect was also seen on the teachers' side. Since few middle-school students raise their hands in class, and as students who do so are often the same ones, it has been difficult to collect the opinions of all students during the limited time of a class. With Manavication, however, a teacher can learn about the opinions of all students in the classroom, which is a fundamental teacher task, and, after all student opinions have been shared, can make time for a lively exchange of more opinions. This process helps to dramatically accelerate and intensify communication between the teacher and students and between the students themselves.

As described above, using the Manavication solution in workshop-type classes was found to contribute to the development of collaborative problem-solving abilities in students. In actuality, this digital educational solution helped develop students' abilities to study a problem from diverse perspectives and to express an opinion concisely, and, in subsequent discussions, to express an opinion on solving a particular problem while respecting the opinions of others. At present, however, there is no concrete means of evaluating improvement in such skills. In some schools, students are asked to perform a self-evaluation after the class, but this would still be subjective in nature as opposed to an objective assessment. Looking forward, with the aim of recording a student's learning activities in the form of a portfolio, a general-purpose mechanism will be needed to measure acquired skills (here, collaborative problem-solving abilities) and not just assess the opinions expressed on an issue presented in class.

6. Conclusion

This paper described "Shu-Chu-Train," a modular learning system that can be regularly used to maintain

and improve fundamental knowledge and basic skills, and "Manavication," a collaborative learning support system developed to support the development of collaborative problem-solving abilities. Each of these systems is just one means of dealing with current problems in education. Key questions relevant to the classroom of the future, such as, "What abilities should be developed in the student?" "How should the style of conducting a class be revolutionized to that end?" and "What kind of system is therefore needed?" still need to be addressed.

As emphasized at the beginning of this paper, the digitization of education is accelerating, and the abilities expected of students are becoming increasingly diversified. Under these conditions, we would like to contribute to the creation of a new 21st-century style of learning for all children, who carry the hope for the future.

References

1) Ministry of Education, Culture, Sports, Science and Technology (MEXT): New Educational Guidelines—Developing Life Skills in Students (in Japanese). *http://www.mext.go.jp/a_menu/shotou/new-cs/*
2) A. Shirota: The Work of a School Principal. Kodansha Ltd., 2014 (in Japanese).
3) Ministry of Education, Culture, Sports, Science and Technology (MEXT): Basic Curriculum Framework (in Japanese). *http://www.mext.go.jp/b_menu/shingi/chukyo/chukyo3/004/siryo/07091203/001/007.htm*
4) Wada Junior High School in Suginami-ku, Tokyo: Research Workshop (February 15, 2013) Report (in Japanese). *http://wadachu.jp/about/ict-20130215.html*

Hidehiko Mayumi
Fujitsu Network Solutions Limited

Mr. Mayumi is engaged in the planning and development of next-generation solutions using smart devices with a focus on digital educational materials.