

# Production of Learning Materials for Special Education Support Adjustable for Individual Capabilities Using a Tablet Device

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## Abstract

In recent years, as a result of improvements in the awareness of people and development of medical science, the number of children diagnosed with developmental disabilities tends to increase. Special education has been reviewed in the Developmental Disabilities Assistance Act of 2004, which has been since being adopted by the education field.

Special education must be devised for teaching materials and learning content to suit the student. For this reason, making a high-quality learning on an ongoing basis is difficult.

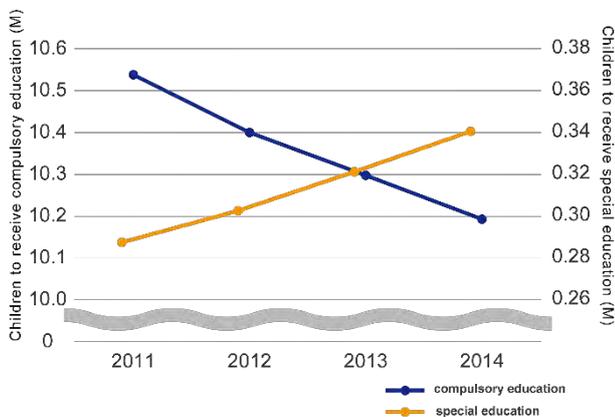
Therefore, the use of a teaching device that is suitable for this specific kind of education is effective. In recent years, the introduction of tablet computers to the education field has been increasing. Tablets can be easily operated, and it is possible to include content with audio and video features, which is beneficial for special education. Many studies have been previously made, however these are still only case introductions or reports on usage of tablet devices in the classroom. In our investigation, no practical case that the included actual teaching materials was found.

In this study, we produce learning materials for the iPad, which is easily available for students receiving special education, and can support them continuously in self-learning activities. We propose to find a new direction for special education materials in the future.

**Keywords:** Support for special education, Tablet device, Learning materials

## 1 Background

The number of students diagnosed with developmental disabilities has been increasing. According to a survey of the Ministry of Education of Japan, by the 1st of May 2014 0.34 million students are receiving some kind of special education; from a total of 10.19 million of Japanese students belonging to compulsory education, 3.33% are in special education programs. (Figure1)



**Figure 1** Transition of the number of children to receive compulsory education and special education

The “Developmental Disabilities Assistance Act” was created as a response to this trend, which is the leading association for development support of national and local governments on special education in schools. Educators have now given the task of dealing with this increase in the number of special education students and they have been reviewing learning support methods. Special support education is performed in a one-to-one method between teachers and students because it is necessary to examine the learning contents that suit the student’s degree of disability and to plan accordingly. The current number of teachers is insufficient, this is because special support classes are organized for maximum six students, and one teacher for each class is assigned. Compared to the regular class of one teacher for about forty students, the special education requires more human resources.

In order to solve this problem, studies about the introduction of digital teaching materials that effectively support special education have been performed in Japan. Specially, there has been a growing expectative on the usefulness of tablet devices. Some of is this reasons are that tablets can be intuitively operated through a touch panel, visual and audio stimuli for

learning can be incorporated, also they are portable and easy for children to handle at any time. However, the actual number of schools that uses tablet devices is small because it takes a lot of time for the teachers to search for content suitable for the students.

Taking the above points in consideration, we visited special support classes in two junior high schools. Both of the schools take advantage of digital teaching materials through computers and large-screen televisions; children have been mastering the equipment with ease. When we asked the instructor about the use of digital teaching materials, she responded: “Teaching materials that include video and music can be used in classes for maintaining the motivation of children that have difficulty visualizing the learning contents”.

In special support classes, children have differences in their individual academic performances. Therefore, it is difficult to proceed with the development of teaching materials in the same way as regular classrooms.

Since the digital teaching materials are still in an introduction phase in order to be used in regular classrooms, studies around digital teaching materials that respond to the minority of special needs education has not been enough.

## 2 Objective

This study aims to develop a learning application for tablet devices aimed at special education. The difficulty settings of this application are designed in a way that can be changed in order to balance the difficulty of learning contents corresponding to the students’ individual capabilities. In addition, a system that implements game elements in order to enable students to learn while having fun will be developed. In order to make reviews of contents already learned by the students, questions using the drill method were prepared for the units of national language and mathematics.

## 3 Related research

As a related example, "Magical pencil box project" was investigated. This is a research about tablets applied for special education; it was initiated by the Research Center for Advanced Science and Technology by the University of Tokyo in collaboration with SOFTBANK MOBILE Corp. In this project, a manual that summarizes important points for tablets utilization in education was created. However this study is limited to introducing the usage of tablets and explaining how to implement them in school classes. (“Magical pencil box project”: <http://maho-prj.org/>)

## 4 Previous Research

In a previous research, we developed an application for tablet devices aimed at special education that included activities for basic mathematics.

In this application, a variety of characters appeared, and the player recruited them as companions by giving the correct answers to mathematics problems. Thanks to this, the students were able to learn with enthusiasm. Furthermore, there was a set of movable blocks that helped the users to make calculations. (Figure2)



Figure 2 Content flow of the previous research

A verification experiment took place in a special support education class, and the results obtained demonstrated that the students could study longer than usual because they showed an interest in the characters.

We concluded the following:

1. Incorporating the game into the teaching material was effective for reducing stress and adverse feelings on learning.
2. It is possible to increase the sense of accomplishment by actively showing a positive response when the correct answer is given.
3. It is possible to offer the liberty of selecting different learning methods for children that influence their motivation for learning.

On the other hand, we got feedback from teachers that suspected that some students felt frustrated because their range of learning was small.

Also, from the observation on the students’ behavior, we concluded that a user interface that responds to double tap and "barrage" tapping gestures should be implemented.

We took the findings of this previous research in consideration in order to make improvements. (Figure 3)



Figure 3 Photos of the on-site experiment

## 5 Contents Design

### 5.1 Overview of content

In this research, we developed an application with teaching materials for tablet devices aimed at supporting special education. It was designed based on the units of Elementary School as a learning support tool with the purpose of transmitting a deeper understanding of topics that the students are currently learning.

The content consists of two sections, national language (kanji) and mathematics. The kanji teaching material incorporate the understanding of radicals through images. Mathematics included basic sum, subtraction, multiplication, along with the knowledge for calculating time and money.

Furthermore, an equipment system was designed in order to offer the players the possibility of changing the difficulty and adapt the application to their own skill level. Also a record page was implemented in order to show the player's achievements.

### 5.2 Content flow

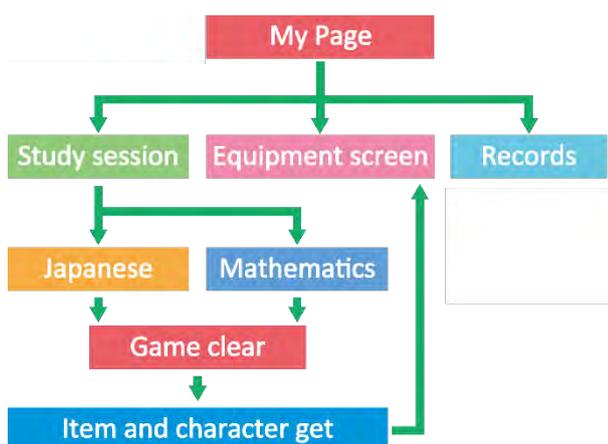


Figure 4 Content flow of this application

In Figure4 a diagram showing the flow of the developed application is presented. At the beginning of the application, a boy or girl main character can be selected. Then, the selected character appears along with the home screen, and from there, it is possible to navigate to each page. The player can select to start a study session, change their avatar's accessories in the equipment screen, or view their records. (Figure5)



Figure 5 Flow to the home screen

The learning contents include the units of national language and mathematics. There are different characters corresponding to each of the learning units. By achieving goals in the respective units, they receive medals as rewards.

The users can change the equipment of their avatar in the equipment screen in order to adjust the difficulty of the teaching materials.

In the records screen, the player can check their achievements like a picture book.

### 5.3 Specification of content

- National language unit (Figure6)

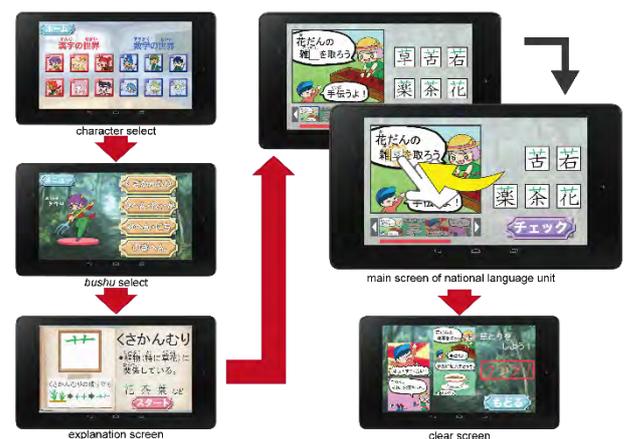


Figure 6 Flow of the national language unit

The national language unit deals with the Japanese kanji, taking particular note of the *bushu* (radicals) in order to learn the kanji through associating the meanings of the *bushu*. When a *bushu* is selected, an explanation screen is displayed. After reading the commentary, the start button is pressed and an activity of filling the blanks on a four-frame comic begins. The player has to fit the correct kanji according to the comic's story. If the correct answer is given, the kanji fits into the blank and a success response is displayed. When all the blanks are filled, the story is completed and the user can read the four-panel comic. This way, it is possible to check again the kanji that has been studied.

According to interviews with the teachers from the special education classes, learning each *bushu* systematically in a coherent and comprehensive way helps with the understanding of the more advanced contents. Furthermore, it is known that by working with stories that show the kanji's usage in context, it becomes easier to visualize the meaning of the kanji, therefore short stories presented as four panel comics were employed.

- Mathematics unit (Figure7)

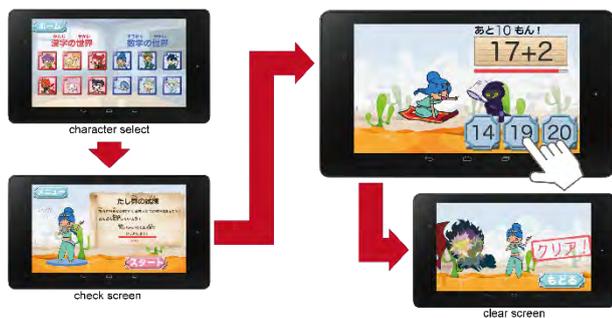


Figure 7 Flow of Mathematics unit

The mathematics unit includes basic arithmetic operations related to calculation of money and ways of reading time necessary for everyday life.

When a learning stage is selected, an escaping game where a character has to run away from a monster begins. In order to prevent the monster from getting close, the user has to select the correct answer from three choices within the time limit.

If the answer is correct the character proceeds to the next question. When the answer is wrong, the character remains inoperable for a certain amount of time, meanwhile the monster approaches from behind. If the monster reaches the character, the game over screen is shown.

When the player answers correctly all of the problems within the time limit, the stage is cleared and an animation showing the monster exploding.

Solving several short calculation problems in a limited time serves for getting used to numbers and improving the precision when making calculations. The objective of this material is that instead of problems that require a long thinking time, like the ones found in textbooks, several calculation problems thought as minimum requirement for practical life are implemented in order to cultivate the students' autonomy.

- Change of equipment (Figure8)

The students can change the equipment of their characters in order to make the problems easier or harder. For example by equipping a certain item, the number of problems found in the stages is reduced, or the time limit is extended. This is a method for provisioning educational material with the possibility of changing the difficulty level according to the each student's needs. Furthermore, changing the difficulty through equipping different costume parts results in an enjoyable action. The changed equipment is shown in the home screen with the character wearing the current selected pieces.

Regarding the time limit, the answer speed for each problem varies depending on the student. The time can be increased for those that need more time for thinking, also the number of questions can be reduced for students who can't focus for long

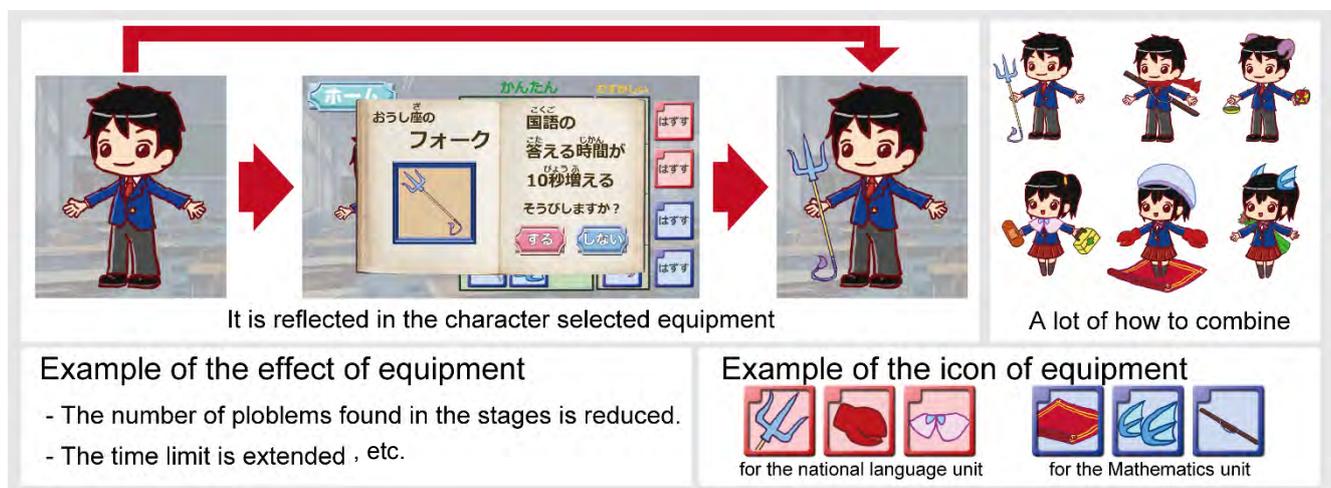
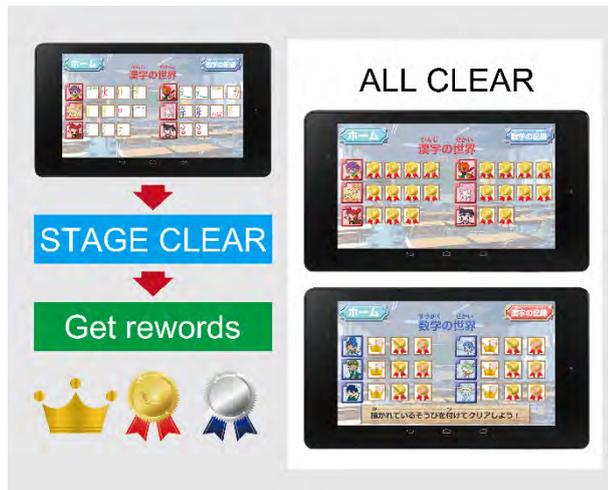


Figure 8 Overview of change of the equipment

periods of time. This is implemented in order to help them find the best way to easily solve the problems. Furthermore, the system allows increasing the materials' difficulty in order to further improve the learning level. The way in which the desire to be challenged is stimulated is explained in the Records screen section below.

- Records screen (Figure9)



**Figure 9** Records screen and complete screen

The cleared stages corresponding for each subject can be viewed in the records screen. In the case of clearing a level with regular difficulty, a silver medal is displayed as reward. However, if cleared with one or more of the equipment pieces that increase the difficulty level, gold medals can be achieved. Furthermore, if the level is cleared using all of the equipment that increases the difficulty level, it is possible to win a crown. This reward system corresponding to the degree of difficulty is aimed at improving the learning motivation of the students.

When the difficulty level is increased, better prizes can be achieved. This was implemented as it serves for encouraging the students' desire to be challenged.

## 6 Verification experiment

A verification experiment was conducted in order to test the digital teaching materials produced in this research, and determine their effectiveness for special education support.

The tablets containing the application were lent to special education's classes for a few days. This was made in order to create an environment in which children could freely use the material. A total of 21 students participated in the experiment.

The evaluation was carried out in two ways: interviews with the classes' supervisors and individual surveys for the children. (Figure10)

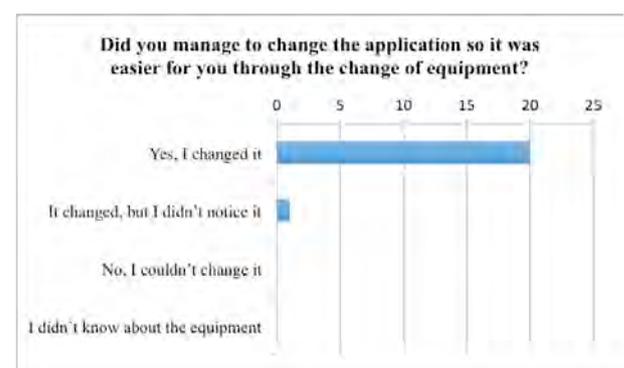
The contents of the questionnaire were: whether the teaching materials were fun, the difficulty level, whether it was easy to use, Whether the equipment and achievement systems were significant, and finally an open question on their general thoughts about the teaching materials.



**Figure 10** Photo of verification experiment

According to the survey's results, most of the students showed positive results towards both of the learning units. However, a portion of the students that regularly have aversion towards studying, felt that the application was boring. We felt that further investigation should be pursued in order to create contents that this kind of children can also enjoy.

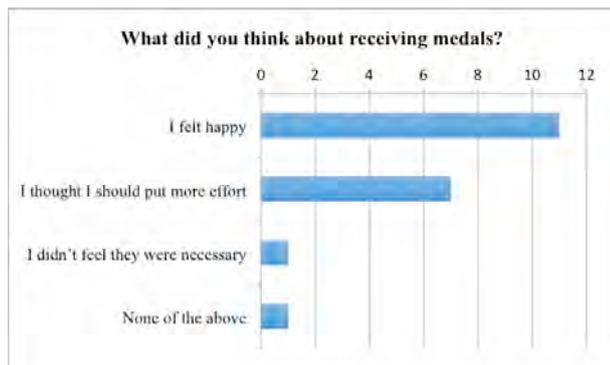
The answers to the questions regarding to the teaching material difficulty showed that almost all of the tested students considered the contents easy. This was because the learning contents included in the application were meant to be a review of things already learned in the elementary school curriculum. Because of this, we consider that content that can expand the current learning material should be implemented in order to present a further challenge for the students.



**Figure 11** The result of question about the effectiveness of the equipment function

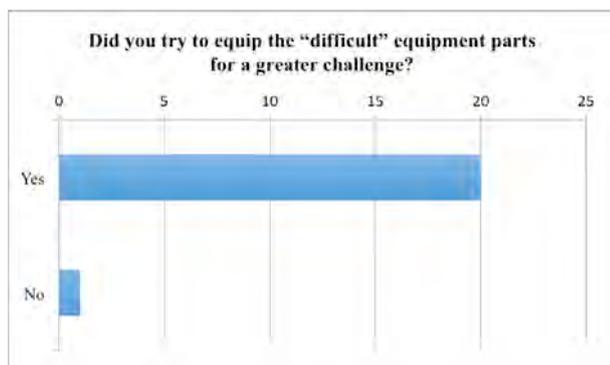
The equipment system made for changing the difficulty of the stages showed to be enjoyable for most of the children. This system resulted useful for responding to each student's needs, along with interesting them with the parts visuals. On the other hand, it resulted boring for the students to have all the equipment from the beginning, and that they had little variation among them. We concluded that new equipment should be obtained through the progression of the game, along

with making improvements on the visual design.



**Figure 12** The result of question about medals

The achievements in the records screen proved useful since the students showed interest in obtaining them and tried increasing the difficulty level. The students felt motivated to tried harder challenges because they saw their effort represented in a visual way.



**Figure 13** The result of question about "difficult" equipment

However some students were uninterested in the rewards because they were not real physical things.

In addition, all of the students except for one person responded positively when asked if they would like to use teaching materials similar to the one developed in this study. From the above we concluded that the application resulted useful and it represent a step forward for developing teaching materials for tablets in the future.

Below, the overall impressions as described by the students on the last question of the survey are summarized.

#### Positive content

- "I could check some kanji that I didn't know."
- "I think anyone can enjoy it"
- "I tried to get the gold medals because it was frustrating to see the game over screen"
- "I was very happy when I was able to complete all of the gold medals"

#### Demands on specific content

- "It would be good to have dialogue and stories for each character"
- "I would like to see the characters in the mathematics games have better movement"
- "I want to get equipment by clearing stages"
- "I would like to try more difficult problems"
- "I want to have a way of reviewing the answers I had wrong"
- "I would like to have other school subjects, such as science or social studies"

From the demands on specific content from the students we reached the following conclusions.

Since the students had a positive reaction towards the characters, developing them further through dialogues and story elements could enhance their effect. There was also a comment about improving the movement of the characters in the game, meaning that animations should be implemented. Also, for each stage, besides getting medals and other types of equipment, ways of implementing harder challenges for the students should be thought in order to sustain their motivation.

Additionally, time to think on the answered question should be considered in future teaching materials. Rather than starting over from the beginning when a problem is answered wrong, there should be system that focus on learning how to solve the wrong problem. We also learned that students would like to see these kinds of teaching materials for other subjects such as science and social studies.

After the verification experiment, interviews of the teachers took place. The opinions and impressions of the educators are summarized below.

- In regards to the kanji stages, using the *bushu* for explanation was a good thing, since the understanding of the radicals has a great influence on remembering the kanji.
- We would like to see other teaching materials that not only show how to read the kanji, but also focus on writing them.
- About the mathematics stages, teaching about the calculation of money through games resulted in an enjoyable experience for the students. We would like to see questions that incorporated real life examples, for example counting change when buying something in a shopping mall.
- Regarding the equipment function, the students seemed to understand and use the system with ease.
- The records screen was useful for visualizing the student's own achievements, was a good method.

- We would also like to see in the future these kinds of materials for other subjects such as science and social science, but also for sub-subjects such as art and home economics.

- In addition, teaching materials on tablets could be aimed not only at children with learning disabilities, but also for children.

We received a positive response from the educators in charge of the special needs classes. Furthermore, they showed high expectations for future digital teaching materials, not only for topics included in the curriculum of the school, but also in various activities related to the special education needs classes, for example keeping a diary or administrating the students' time schedule.

We also observed the student's way of appropriating the application and noticed that they showed a competitive behavior. They talked among themselves in order to start the same stage at the same time and competed to clear it first. Because of this, a system that encourages this competitive behavior could be implemented in order to further enhance their motivation to get better. (Figure14)



**Figure 14** The competitive behavior

## 7 Conclusion

In this study we proposed a different approach for making teaching materials directed towards special education. This consisted in making an application on tablet devices that included video games in order to motivate the students to learn by themselves and improve their will to learn. In addition, a system that could let the students change the difficulty of the educational contents in order to address their respective academic level was thought.

The result of the verification experiment showed that with the video games embedded teaching materials it was possible to improve the motivation of the students in learning, and also reducing adverse feelings towards studying. Furthermore, offering rewards in the form of digital achievements, along with the optional difficulty selection, resulted in the will of taking higher challenges.

On the other hand, the rewards contents, the reward acquisition timing, and the conditions for clearing a stage needs to be reviewed in order to address the issue of students that found the contents too easy and felt boredom.

Teaching materials for special education support should take in consideration ways of corresponding the individual needs of students according to their each educational level. It is also important to transmit the contents that should be learned in a manner of objectives easily recognized, such as the stages on a game user interface. In addition, it is important to include problems that deal with real life situations in order to facilitate the understanding of certain contents. This investigation expects to serve as basis for future research regarding development on special education's resources.

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