STRATEGIC APPROACH FOR SHARING EDUCATIONAL MATERIALS ON REMOTE SENSING

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Commission VI

KEY WORDS: eLearning, Flash, Web, Training, Edutainment

ABSTRACT:

Due to the various earth environment issues, interest to remote sensing is increasing. Especially, educational materials on Internet are much in demand. For the passed several years, the authors have been developing interactive educational materials on remote sensing with Adobe Flash software, which were well accepted by the students and the teachers. However, usually, development of such educational materials takes a lot of time. The development of a system for sharing educational materials among various scientists and educators is necessary. In this paper the authors propose a strategic approach for setting up a kind of system for developing and sharing educational materials on remote sensing with other scientists and educators. We call this system as LESSON (Learning Environment Sharing System On the Net). In this LESSON, four teams are planed to be set up for developing and sharing educational materials. The four teams are Scenario Team (Team-S), Development Team (Team-D), Evaluation Team (Team-E), and Translation Team (Team-T). So, scientists or teachers who are interested in LESSON can join in one of the four teams according to their interest or skills. The template materials with a manual will be provided to the members to support their development of the materials. The educational material developed in LESSON will be open to the public via Internet. The each developed materials can be gathered as a module using an editor developed by the authors. So, the teachers can produce their own module by according to their particular needs. The international framework of sharing educational materials on remote sensing LESSON may expand the possibility of developing educational software for remote sensing.

1. INTRODUCTION

Due to the earth environmental problems, interest to remote sensing and needs for remote sensing education are increasing. The Internet and e-learning are playing significant roles in remote sensing education. Nowadays, various educational materials on remote sensing are open to public via Internet. Those materials can be classified into five types.

The first type is textbook type material. "Fundamentals of Remote Sensing" of CCRS(2008) is a good example of the textbook type material(see Figure 1(a)). The basic ideas on remote sensing are explained in plain words with understandable diagrams. Beginners can learn about remote sensing like reading a textbook.

The second type is power point/slide type material. In various universities, professors are uploading their power point type teaching materials in pdf format on their web site to support their students. Though user cannot get detailed explanation from this type of material, visualized figures and compact explanations are sometimes much understandable than text type material.

The third type is VOD(Video on Demand) type material. In this type of material, the teacher's lecture video is synchronized with the power point material. So, that user can feel like he or she is actually listing the lecture in a classroom. JICA NET Distance Education on Remote Sensing is a good example (see figure 1(b)).

The fourth type is lesson plan type material. "An Introduction to Remote Sensing" of Science NetLinks(2008) is a good example. This type of material is mainly prepared to help teachers to learn how to teach remote sensing to their students.
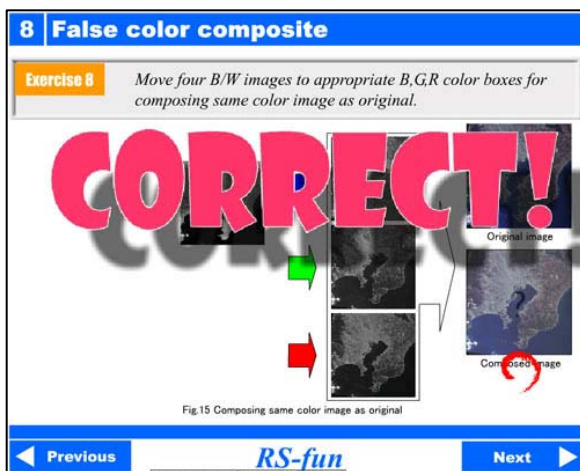
The fifth type is interactive game type material. Graphical and interactive operations are realized in this type of materials using Java and/or Adobe flash technologies. The RS-fun and GT-Simulator developed by the authors are categorized to this type of material. With the game type of functions, the user can learn about remote sensing with some fun (See figure 2).

(a) CCRS

(b) JICA NET

Figure 1. Examples of educational materials on Internet.
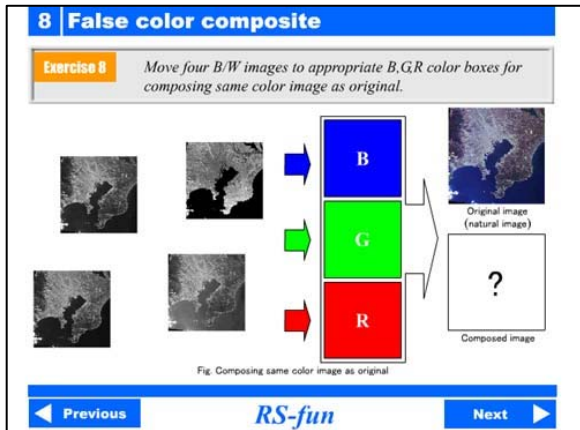
(a)Exercise

(b) Answer check

Figure 2. RS-fun : An interactive game type material.

Among the above five types of educational materials on Internet, the interactive game type materials have strong advantages against traditional educational materials. In this paper, two examples of this kind of educational materials developed by the authors are introduced. One is RS-fun and the other is GT-Simulator. However, in order to develop this type of material, one has to be skilled in using Flash type of software for the development. Moreover, it is quite time-consuming work. As a matter of fact, the number of this type of educational materials on remote sensing is still limited. In order to expand the development of this type of educational materials, the authors propose a strategic approach for sharing educational materials for remote sensing in this paper.

2. ADVANTAGES OF INTERACTIVE GAME TYPE MATERIALS

2.1 Concept of Edutainment

For years, the authors have been involved in developing educational material for remote sensing. In order to optimise the advantages of e-Learning and to interest beginners in remote sensing, the authors have introduced the concept of "edutainment: education + entertainment" for developing educational materials named RS-fun and GT-Simulator. Edutainment is a form of entertainment designed to educate as well as to amuse. By introducing game type functions, the user

can learn certain concept with some fun. Advantages of interactive game type materials are described in this chapter by introducing RS-fun and GT-Simulator.

2.2 RS-fun

RS-fun (Cho et. al. 2004) is a kind of Q&A game on the Web, and allows users to learn about the basic concept of remote sensing with some fun. The target users of RS-fun are beginners of remote sensing, including high school or lower grade students who do not know much about remote sensing.

2.2.1 System Configuration

RS-fun is developed using html language and Adobe Flash software. Flash is used as the authoring tool to provide interactive operations with various visual effects to make users feel more like playing computer games. RS-fun is installed on the web server of Tokai University, so multiple users can use RS-fun on their PCs connected to Internet. In order to utilize Flash functions, users have to install free software Flash player to their PC before using RS-fun. The Flash player can be downloaded from Adobe homepage on free of charge. Figure 3 shows the system configuration of RS-fun. RS-fun mainly consists of three modules which are Q&A Module, Jigsaw Puzzle Module and Database Module (see Figure 3(b)).
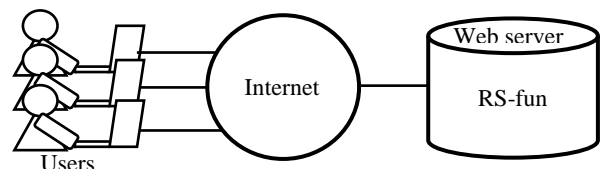

(a) Hardware configuration
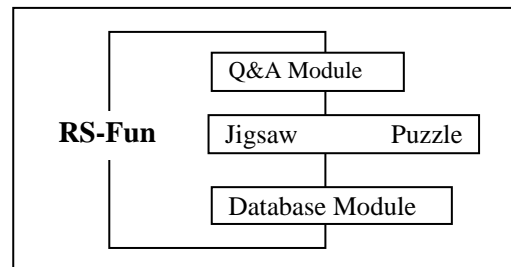
(b) Software configuration
Figure 3. System Configuration of RS-fun

2.2.2 Q&A Module

The Q&A Module is the main part of RS-fun. The Module consists of a series of sections. In each section, some particular subject is explained with a set of question and answer(Q&A). In making this kind of Q&A type educational materials, there are mainly two procedures as shown on Figure 4. One is "Explanation-after-Q&A" and the other is "Explanation-before-Q&A".
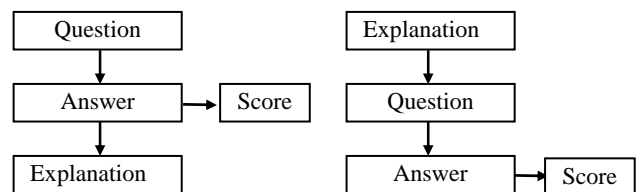
(a) Explanation-after-Q&A   (b) Explanation-before-Q&A
Figure 4. Procedure of Q&A

In the "Explanation-after-Q&A" procedure, some questions on a certain topic are asked first, and then answer and explanation about the concept will be followed. In this procedure, question will raise user's curiosity about the topic and motivation to read the explanation will be increased. But, if the user's answer was right, the user is likely to skip reading the explanation even though he or she were not really understanding the subject.

In the "Explanation-before-Q&A" procedure, the concept of a certain topic such as "reflectance" is explained first, and then questions about the topic will be asked. Since the answer of the question is usually included in the explanation, the user can check their understanding about the explanation of the topic, and the score of the result will reflect the level of their study achievement. By giving wrong answer, user can recognize his/her misunderstanding on the subject. But, on the other hand, in this procedure, users sometimes have to read the explanation without their interest on the topic. Since RS-fun is prepared for the beginners who are interested in remote sensing, we decided to mainly use the former procedure.

Figure 5 shows the operation procedure of Q&A Module. The Q&A Module consists of a series of sections. Each section deals with one particular topic on remote sensing such as "Spectral reflectance" or "False color composite".
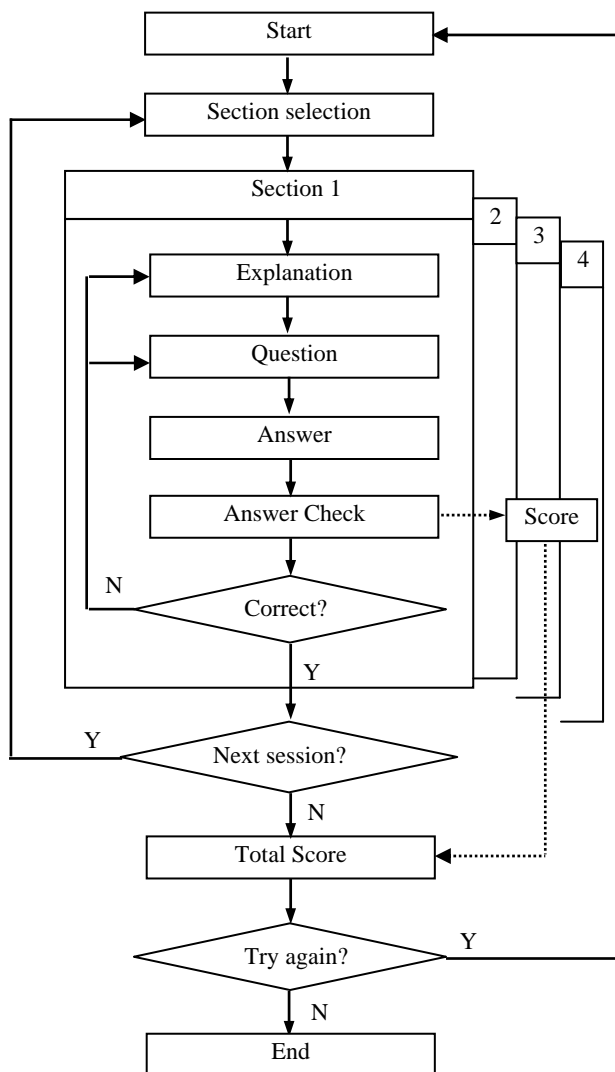
At first, a user selects a section and starts reading the text explaining the topic of the section. Figure 6 shows an example. The subject of this section is "Spectral reflectance of vegetation." After reading the explanation (Figure 6(a)), the user has to do an exercise (Figure 6(b)). In this case, the user has to select a right wavelength from the three alternatives. According to the user's answer, the message "wrong" or "correct" would be displayed on the screen as shown on Figure 6(c). If the answer was wrong, the user can read the explanation and try the exercise again if he/she wanted. In this way the user can check his/her understanding of the subject. After finishing one section, user can move on to the following sections

Figure 5. Operation Procedure of Q&A Module
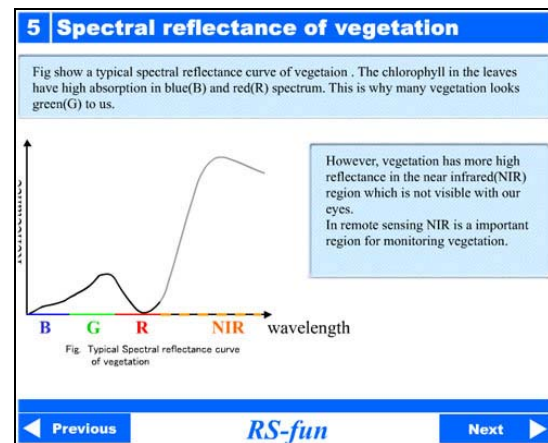
(a) Explanation on the subject.
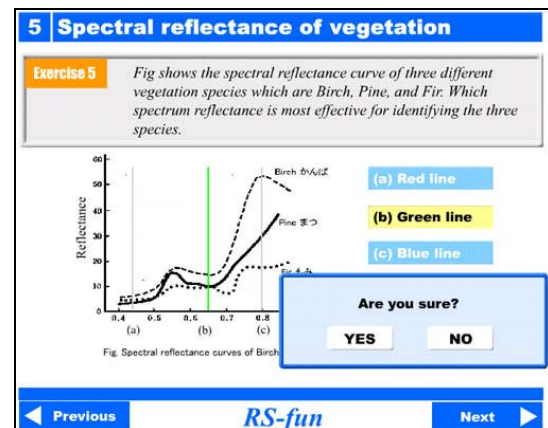
(b) Give a answer to the question.
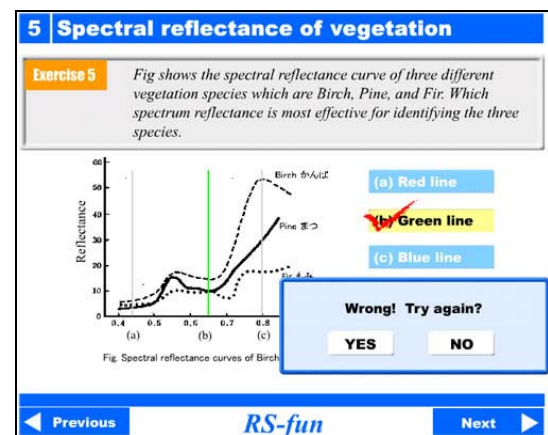
(c) Answer check

Figure 6. Graphical operation examples of Q&A Module.
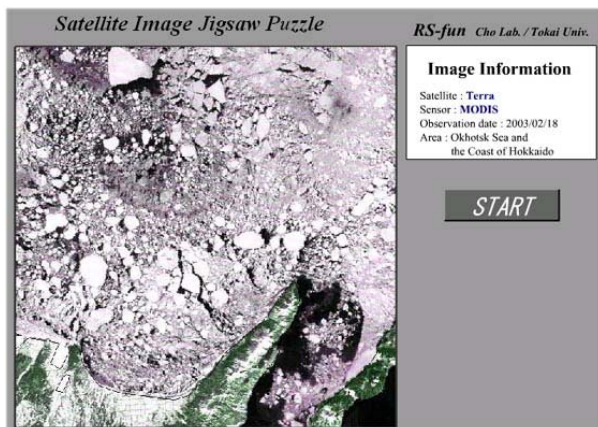
2.2.3 Jigsaw Puzzle Module

The Jigsaw Puzzle Module contains a series of digital jigsaw puzzle of satellite images such as of Landsat/TM, JERS-1/SAR, Terra/MODIS, IKONOS. Figure 7 shows a jigsaw puzzle of MODIS image of the sea ice area of the Okhotsk Sea. When a user push the start button, the satellite image is divided in to 5 x 5pieces, shuffled and put on the right hand side. The user has to move each piece to right place to re-construct the original image (see Figure 7(b)). By pushing the NAVI button, the original image is displayed in light colors, which help the user to find the right place to put each piece.

The jigsaw puzzles are not prepared only for fun but also to give good chance for the beginners to carefully look at satellite images. By reconstructing the original satellite image, users are likely to see the detailed pattern of the image. Moreover, satellite name and sensor name are hyper linked to the Database Module to give detailed information of the satellite and the sensor.

In order to make user's satisfaction, the lapsed time is displayed in the bottom of the jigsaw puzzle (see Figure 7(b)). This will force users to try again and again to improve their time for completion. Through several times of trials, users are likely to finds typical characteristics of the satellite image with some enjoyment.

2.2.4 Database Module

In various educational materials on remote sensing, most of the beginners are confused with the technical terminologies of remote sensing including satellite names and sensor names.

(a) The first page of jigsaw puzzle
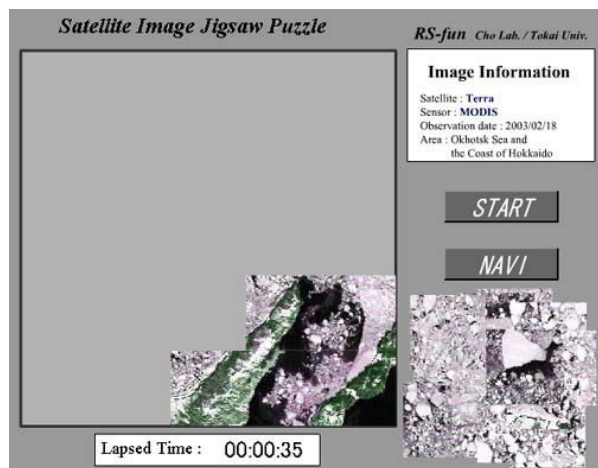
(b) Reconstruction of the shuffled image

Figure 7. Jigsaw puzzle of MODIS image of sea ice area

Database Module of RS-fun consists of various kinds of information related to remote sensing. Important terminologies such as "electromagnetic wave", "platform", satellite names in the Q&A Module as well as in the Jigsaw Puzzle Module are hyper linked to the Database Module, so the user can learn more details on the terminologies.

2.3 GT-Simulator

Spectral measurement using spectral radiometer is one of the most basic and important ground truth measurements in remote sensing. By performing the spectral measurement, beginners of remote sensing can easily understanding the concept of remote sensing. However, since spectral radiometers are usually quite expensive, it is not easy for most of the beginners in remote sensing to experience the measurement. In order to allow beginners to virtually experience the ground truth spectral measurement, the authors have developed a software package called GT-Simulator. GT-Simulator is accessible via Internet from an Adobe flash player installed PC. GT-Simulator is a kind of roll playing game. By using GT-Simulator, beginners can learn the basic idea of ground truth spectral measurement. The hardware configuration of GT-Simulator is same as RS-fun (See Figure 3(a)). T-Simulator mainly consists the following three chapters.

2.3.1 Chapter 1: Concept of remote sensing

The first chapter is a introduction of remote sensing, and is a revised version of RS-fun. It consists of the following seven sections.

1-1. What is remote sensing?
1-2. Reflectance property of objects
1-3. Application examples of remote sensing
1-4. What is reflectance?
1-5. Electromagnetic spectrum used in remote sensing
1-6. Spectral reflectance curve
1-7. Spectral reflectance difference

The Q&A type educational materials allow users to learn some basic concept of remote sensing.

2.3.2 Chapter 2: How to measure spectral reflectance?

In the second chapter, the concept of how the spectral reflectance factors are measured with spectrometer is explained. It consists of the following 5 sections.

2-1. What is ground truth?
2-2. Reflectance and reflectance factor
2-3. Spectrometer and white board
2-4. Procedure of calculating reflectance factor
2-5. Weather condition consideration

In order to explain the procedure f the measurement step by step, animations are effectively used in this chapter. Figure As shown on Figure 8,
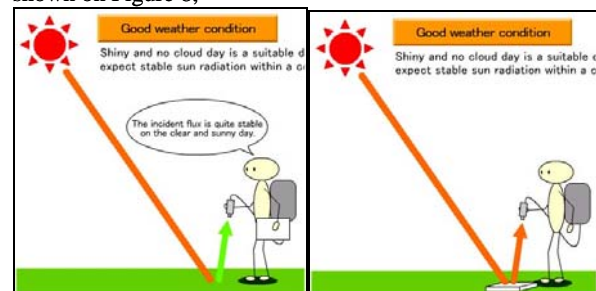

Figure 8. Animation on spectral measurement

2.3.2 Chapter 3 : Let's try!

Chapter 3 is a kind of virtual reality practice of spectral measurement. It consists of the following four sections.

3-1 Let's look at the satellite image for ground truth
3-2. Target objects for measurement
3-3. Spectral reflectance measurement
3-4. Spectral reflectance comparison

Figure 9 shows the flow of the procedure of the operations in this chapter. A park in an IKONOS image was selected as the test site. Six target objects are assigned for measurements which are (1)asphalt, (2)grass, (3)water, (4)broad leaf tree forest, (5)bare soil, and (6)tartan track. First of all the user have to select area for the measurement from the IKONOS image (see Figure 10). Once the area for measurement is assigned, the spectral measurement of the target is performed with animation (See Figure 8)., and the reflectance curve of the target will be displayed (see Figure 11). After measuring the spectral reflectance of all the six targets, some exercises on the spectral reflectance comparison of the targets are given. Through these exercises, user can check his/her understanding of the concept of identifying various objects with spectral information acquired in remote sensing.
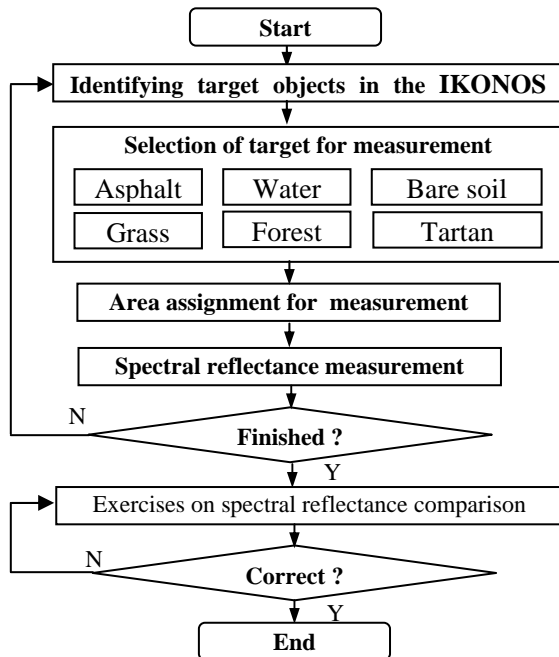

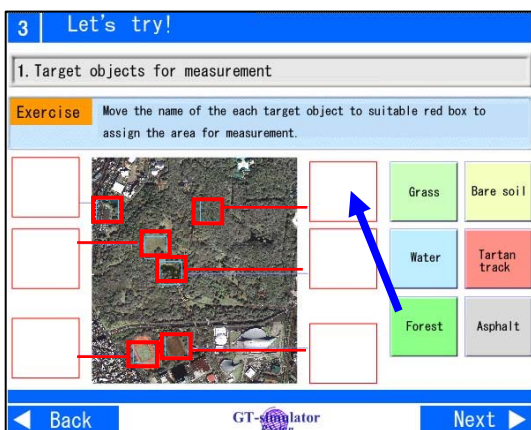Figure 9. Flow of the spectral measurement

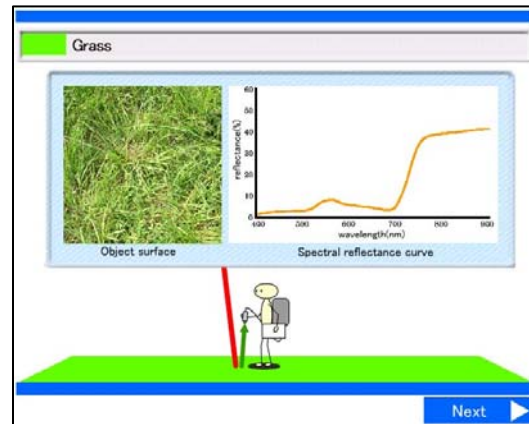Figure 10. Area selection for spectral measurement

Figure 11 Spectral reflectance measurement

2.4 Important aspects

Through the experiences of making educational materials on Internet as described above, the authors have come to realize some important aspects in making effective educational materials.

2.4.1 Graphical Operation

As shown on Figure 12(a), the multiple choice exercise is one of the most common types of exercises used in these kinds of interactive educational materials. However, this type of exercise does not have big difference with traditional textbook exercises. So, introduction of graphical operation is quite important to attract users. In this example, the selection of the answer can be performed by pushing one of the three alternative answer bars like pushing a button. Figure 12(b) shows another example. In this exercise, a user has to move the color bars in right order. Since user can freely move or swap each color bars, the user feel more like playing a game than doing an exercise.
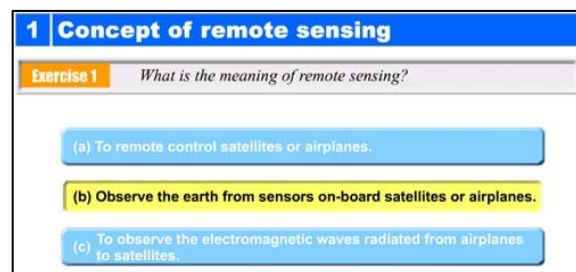

(a) Multiple choice exercise
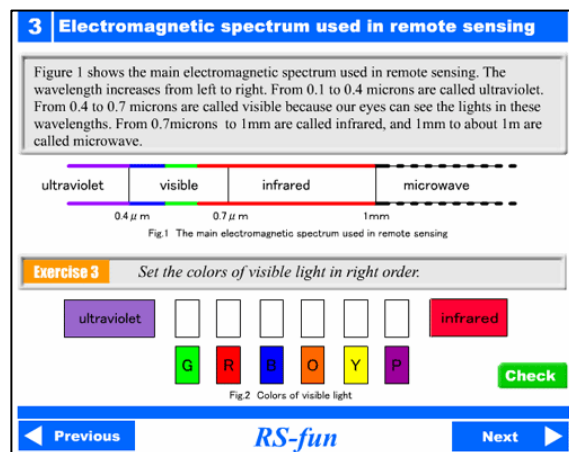

(b) Putting color bars in order

Figure 12. Graphical Operation example used in exercises

3.1.2 Simplification and Materialization

For explaining certain concept, simplification is quite useful. However, once the concept is understood, it is very important to learn more about the reality. Figure 13 shows such an example. Understanding of spectral reflectance curve is one of the most basic and important subjects in remote sensing. However, it is not easy for the beginners to understand the meaning of spectral reflectance curve. In RS-fun, firstly, an exercise of selecting spectral reflectance curves of green and white ball is presented for practice (see Figure 13(a)). Then in the next step, an exercise on the spectral reflectance curve of vegetation is presented for the users to learn about the practical problems (see Figure 13(b)).
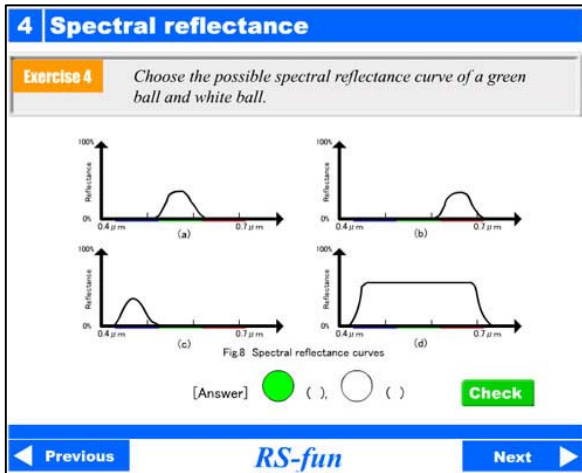
(a) Simplification
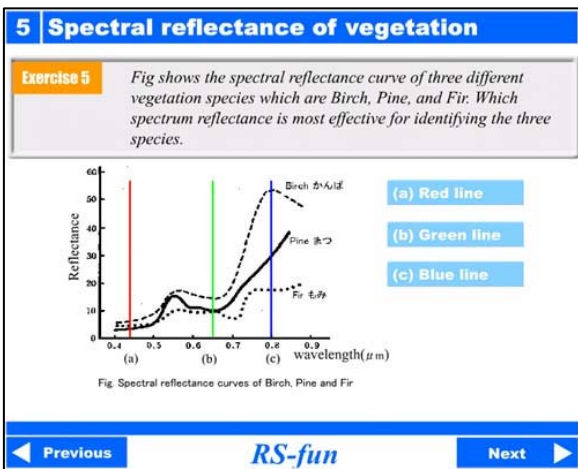
(b) Materialization
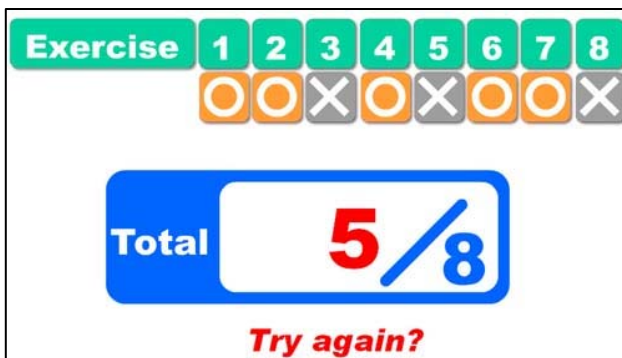
Figure 13. Exercises on spectral reflectance curve.

Figure 14 Score

3.1.3 Score giving

In RS-fun, according to the user's answer, the message "CORRECT!" or "WRONG!" pops up on the screen as shown on Fig. 2. This flashy action gives users strong motivation for answering correctly. Each time user gives a right answer to each questions, one point is given to the user. When the user comes to the end of the sections, the total score will be displayed on the screen (see Figure 14). Like a game, the score will be a good motivation for trying RS-fun again to improve his/her understanding of remote sensing

3. STRATEGIC APPROACH IN DEVELOPING EDUCATIONAL MATERIALS

The concept of RS-fun and GT-Simulator were well accepted by the user community. Needs for these kinds of educational materials are increasing. However, to develop, these kinds of materials take time. Moreover, amount of the materials which can be developed by a small group of educator is limited. In order to share know how, experiences, and ideas of making good educational materials on remote sensing among international scientists and educators, setting up of a framework for cooperation is necessary. Here we call this framework as LESSON (Learning Environment Sharing System On the Net). The authors would like to propose the following procedure for developing and sharing educational materials with other scientists and educators under the framework of LESSON.

3.1 Setting up of Teams

For the effective development of good educational materials, task share is most important. In this LESSON, four teams are planed to be set up for developing and sharing educational materials. The four teams are Scenario Team (Team-S), Development Team (Team-D), Evaluation Team (Team-E), and Translation Team (Team-T).

3.1.1 Scenario Team (Team-S)

Team-S produces scenarios and/or images for making new educational materials. The members of the Team-S do not have to make materials by them selves. So, any kinds of scientists or teachers who are not skilled in making educational material on the web can join the Team-S. Since good scenario is the key for making a good educational material, this team needs experienced scientists and teachers from various application fields.

3.1.2 Development Team (Team-D)

Team-D develops new educational materials according to the scenarios. The members of Team-D should have the skill to use Adobe Flash or similar software for making educational materials on Internet.

3.1.3 Evaluation Team (Team-E)

Team-E evaluates scenarios and/or produced materials, and makes suggestions to Team-S or Team-D if necessary. In making educational materials, understandable and correct descriptions are most important. In this sense, the role of Team-E is quite important.

3.1.4 Translation Team (Team-T)

English will be the basic language in this educational material development. Team-T will translate the texts of the produced materials to the other languages if needed.

Figure 15 shows the relationship of the four teams and users. To keep the quality and concept of educational materials, Team-E finally decides to include a new material to the products of LESSON. Members of each team are not concrete, and can belong to plural numbers of teams.
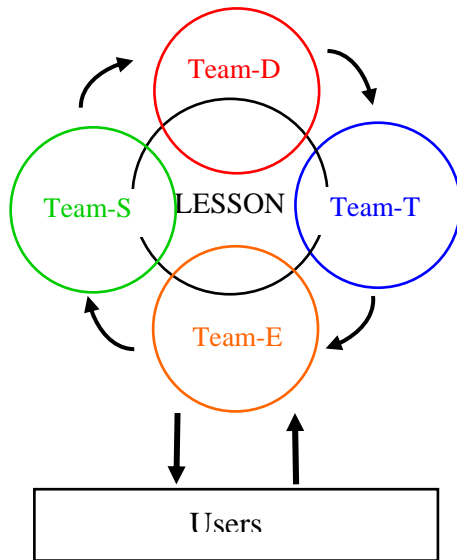

Figure 15. Team structure of LESSON

3.2 Development procedure

The system configuration of the educational materials of LESSON is same as RS-fun as shown on Figure 3. The main part of the development will be the contents of Q&A module (see Figure 5). A section will be the smallest unit of educational material development in LESSON. Firstly, Team-S produces a certain scenario of a new section. The scenario will be reviewed by Team-E, and some modification to the scenarios will be applied by Team-S or Team-E if necessary. The information on important keywords will also be collected. When the scenario is fixed, Team-D starts to develop actual section. The developed section is reviewed by Team-E, and feedback goes to Team-D for improvement.

3.3 Template dissemination

Through our experiences in developing educational materials, we have developed some template of educational materials. By using these kinds of template, the development of educational materials becomes easier. In other wards, by using the template, the educators can develop interactive game type educational materials with less knowledge on Flash software. The templates will be disseminated to the members of LESSON on free of charge. The followings are the line up of the templates of LESSON.
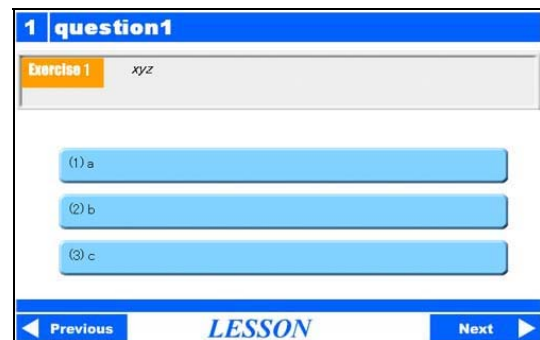
3.3.1 Multiple choices template-A

As described before, the multiple choices exercise is one of the most common types of exercises used in interactive educational materials. Figure 16(a) shows a template of multiple choices exercise we prepared for LESSON. Here we call this template as "multiple choice template-A". By only putting certain texts to question window and selection windows, a multiple choices exercise can be produced.

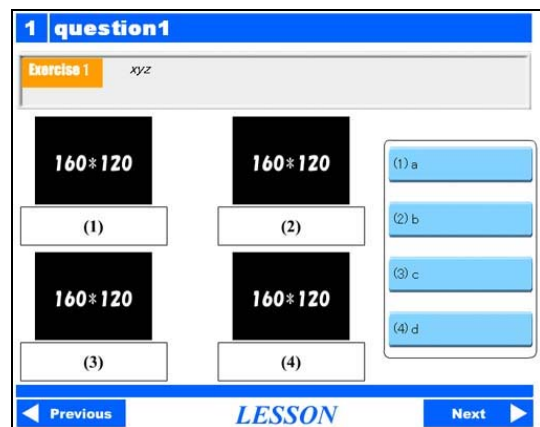### 3.3.2 Multiple choices template-B

It is quite easy to make exercises with the multiple choices template-A. However, on the other hand, such exercises are not so attractive to the users. So, the authors have developed another pattern of multiple choices template as shown on Figure 16(b). Here we call this template as "multiple choices template-B". In this template, four images can be assigned as multiple choices. So the teachers may bring more variations in making exercises.
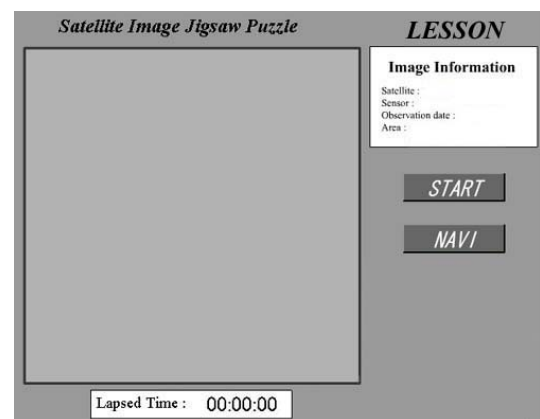
3.3.3 Jigsaw Puzzle template

The jigsaw puzzle template was also developed as shown on Figure 16(c). By using this template, jigsaw puzzle of any satellite image can automatically be produced like Figure 7. Since the satellite name and sensor name of the image can easily be hyper linked to the database, the jigsaw puzzle can play a role as an educational material.

(a) Multiple choices template-A

(b) Multiple choices template-B

(c) Jigsaw puzzle template
Figure 16 Templates of educational materials.

3.4 Formation of educational materials

Basically, each unit of an educational material, here we call "section", developed in LESSON is independent from other sections. In other words, there are various ways to gather sections to form a Q&A Module. The authors have developed a kind of editor to allow teachers to select any sections in any order to form a Q&A Module for their own purposes.

3.5 Dissemination and copyright policy

All the educational materials developed under the framework of LESSON will be opened to public. Anyone can use the materials for educational purposes on free of charge. All the contributors will be clearly indicated on the web site of LESSON. In general, the copyrights of the materials remain to LESSON team. However, for particular images or graphs etc., the copyright may remain to the person or organization that provided them.

4. CONCLUSION

In this paper, firstly, two educational software packages, namely RS-fun and GT-Simulator, developed by the authors were introduced to evaluate the advantages of interactive educational materials for remote sensing education. The both packages were developed under the concept of "edutainment: education + entertainment". Through the development of RS-fun, procedure of Q&A was examined and a number of templates of visually enhanced interactive educational material were set up. In GT-Simulator, the effects of animations for making variations to educational materials were clarified. In explaining certain concept of remote sensing, firstly, simplification was useful for beginners to understanding the concept, but materialization was also necessary for connect the concept with practical measurement. It was also verified that giving score to the answers of exercises increase the motivation of users to try the exercises again to improve their knowledge on remote sensing.

Considering the above aspects, the authors have proposed a strategic approach for setting up a kind of framework for sharing ideas and skills on developing educational materials on remote sensing with other scientists and educators. We called this framework as LESSON. In LESSON, four teams will be set up for sharing tasks in educational material development. The templates of typical exercises were developed by the authors and will be distributed to the members of LESSON. The authors have also developed a kind of editor to allow teachers to gather various educational materials developed in LESSON to form a Q&A Module for their own purposes. The strategic approach of sharing educational materials may expand the possibility of developing educational software for remote sensing.

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