Editing Digital Instructional Materials According to the Virtual Eye Tracker - an Example of Plant Learning

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ABSTRACT:

Due to the advanced technologies and pervading webs, the education method transferred from the traditional education into the digital learning shortens the distance between students and teachers. However, since the digital learning is the asynchronous learning, the availability of the instructional materials proposed by teachers on learning platforms to students remains unknown. The arrangement of the materials relates critically to the reading method of students. Currently, it is applicable to record the students' reading by an eye tracker to know the learner's concentration at the very moment. However, an eye tracker costing more than NT$ 2 million is unaffordable for eye-tracking researchers; thus, a virtual eye tracker simulating an eye tracker is developed so as to help teachers improve the arrangement of instructional materials by observing the learner's reading states with a virtual eye tracker.

Keywords:

Eye tracker, Plant learning, Learning process.

1. Preface

It is necessary for an eye tracker to fix the neck which is neither practical nor convenient at the modern perspectives. Despite the improvement to this defect for the new eye tracker, the length limit exists whilst the verification of eye movement is weakened by the strength of lights.

The instruments demanded by a virtual eye tracker are a video system and a laser pen which cost much cheaper than an eye tracker. The caught images processed by some treatments lead to the identical effect with those of an eye tracker.

The judgment and assessment of digital instructional materials is the main concern of the professional design. As a learning material is designed, the focused or interesting part can be located by the system so as to help instructors add or delete elements for letting learners know the objectives or key points and further facilitate the desire to learn and advance the learning capability.

2. Literature Review

2.1 Technologies of Eye Trackers

Eyes are in charge of the physical perception; thus, the visual presentation lures the attention to be focused or distracted. Both perception and attention are the key parts in cognitive psychology; therefore, the issue that whether the visual perception and the
control over attention help improve the learning effect is studied at the perspective of cognitive psychology.

A. Cognitive psychology

Cognitive psychology consists of perception, attention, memory, image, language, developmental psychology and artificial intelligence (AI) of cognitive neurological sciences. Moreover, attention and memory matter much to the learning effect. The amount and patterns of information relate closely to attention; meanwhile, memory and perception mutually act to make the stimuli perceived a short-term memory and transfer it to a long-term memory by review. At this rate, a learning cycle is accomplished. In 1980, the process of memory proposed by James indicates that the learning stimuli perceived and accepted by the main memory area through learning and thinking will be forgotten as the time passes; that is, only part of memory will enter the long-term memory area. Upon the analysis, frequent reviews help knowledge enter the long-term memory area effectively. Thus, the learning of the attention in the stimuli perception phase and the review phase are the 2 crucial phases of learning. It leads to better results with sound instructional materials and mechanisms of good after-learning guidance.

B. Relation between eye movement and reading attention

Attention is affected by internal and external factors like visual perception, acoustic perception, exhaustion or nervousness. [5][6][8] In 1987, Rizzolatt proposed the Premotor Theory of Attention. Attention is a preliminary step for the eye movement afterward. [9][10] Hence, the concentration of a user can be told by the observation of eye movement. There are 2 mode of fixation and saccade [12] in reading; moreover, the main indicators are fixation duration and saccade length [6][11][1]. The internal cognitive process of reading is shown in Fig 1.

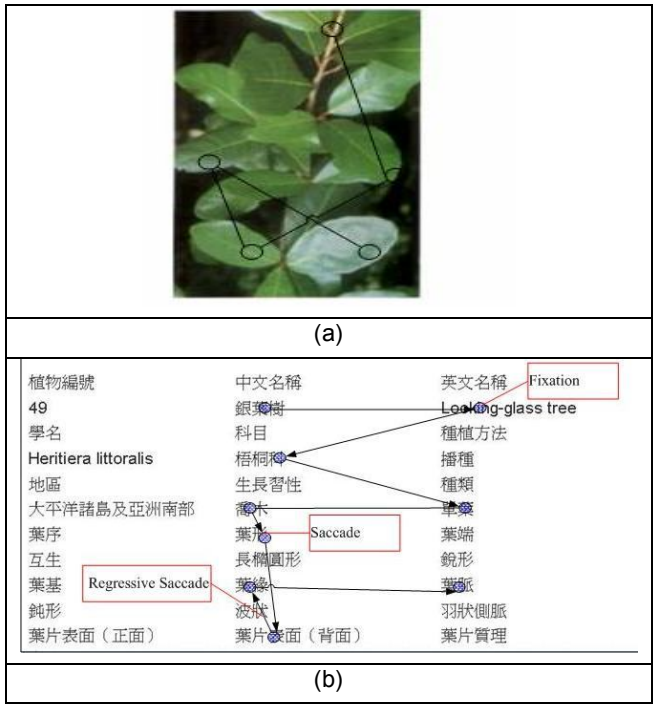

Fig. 1 Reading cognitive demonstration
(a) eye track of graphic reading (b) eye track of verbal reading

The critical objective of an eye tracker is to inquire the relation between the fixation and saccade and the verbal verification and comprehension, especially how the verbal perception and linguistic characteristics impact the decision of where and when of eye movement, how to decide the verbal position of fixation, and when to leave the fixed position.

The eye-tracking indicators frequently used in reading process are listed:

1. Single fixation duration: once fixation of a target area in the first measurement;
2. First fixation duration (FFD): the first fixation duration regardless the single or plural times in a target area;

3. Gaze duration (GD): the time from entering to leaving a target area;
4. Saccade length: the length of 2 fixations with the unit of alphabets or Chinese characters;
5. Skipping rate: the rate of lacking first fixation in a target area;
6. Regression rate: the rate of refixation after the first fixation in a target area;
7. Refixation rate: the rate of the plural fixations after the first fixation by leaving a target area; and
8. Landing position: the place of fixation in a target area which is divided into several sub-areas to represent the front, mid and rear sections of the indicators in the target area.

An eye tracking system is expected to help material designers (teachers) design a set of interesting instructional materials which lures and enables learners to learn and review autonomously; therefore, the eye movement detection is introduced in the learning process to record the learners' use time and focus time so as to improve the learning effects by assessing the students' learning situation and measuring the design and correction of materials.

2.2 Learning Portfolio

The recent web-related technological development has integrated computer and web-based technologies; furthermore, through the instantaneous and interactive characteristics of webs, the temporal and spatial limitation of the traditional data establishment is overcome with the instantaneity of data establishment or maintenance. The web-integrated database not only helps record, collate, search and analyze the data of learning portfolio but also offers the capacity of file sharing and browsing for learners and teachers to increase the opportunity of interaction and observation for learning. Learning portfolio or portfolio [2][4] refers to a way to store personal articles and artwork by filing (portfolio) to understand the personal profile of creative growth. In late 1980s, learning portfolio was formally applied to the educational domain and became an emerging trend. Despite the applied disciplinary domains, the major objective and key point of learning portfolio is an assessing tool. Educationally, it collects the multidimensional data in the learning process by a specific objective or purpose so as to respond to or present the learners' true performance and improvement or changes. Thus, students are able to deliberate and review the learning by collecting and collating learning portfolio whilst teachers may assess the learning by students' learning portfolio in a time rather than realize the students' outcome via the previous paper-pen tests.

3. System Architecture

The study attempts to record the reading track of students in learning by a virtual eye tracker as learning portfolio in the instructional database after a set of materials is designed; afterwards, the data collected in the database are available to teachers for analyzing the conformity of the designed materials to the designed objective.

3.1 System Diagram

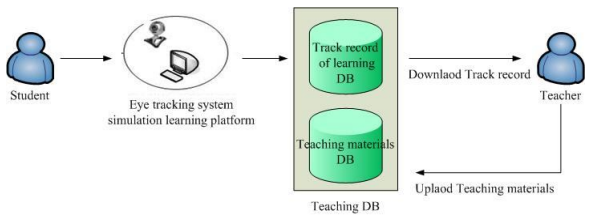

Fig. 2 Virtual eye tracker diagram

3.2 Virtual Eye Tracker

This system is written by Microsoft Visual Studio 2005 C#. The methods offered by DirectShown of DirectX are used to set the fixation intervals for retrieve WEBCAM images. The red point is located by processing the images. The processed red points will produce coordinates which are recorded one by one. Finally, the data are analyzed to locate the users' foci and time distribution. The results are mapped by diagrams.

There are 3 steps of a virtual eye tracking system: preliminary operation, user interface and statistic results as shown in Fig. 1.

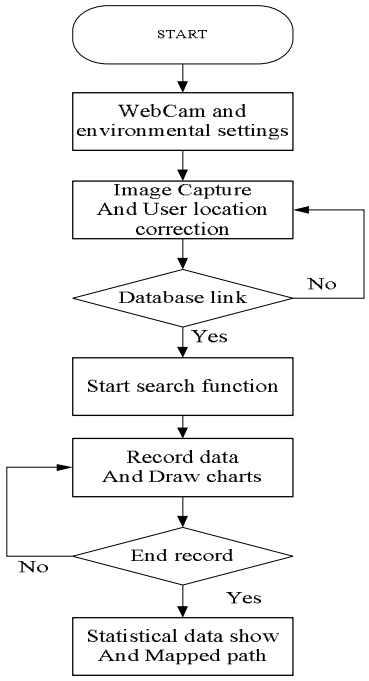

Fig. 3 Virtual eye tracker flowchart

3.3 System Functional Specification

The operating steps are illustrated simply:

Step 1: The system must retrieve the screens to be analyzed and select the target items to be analyzed, and name the items one by one as the names of the categories for the final statistics. (Fig. 4 Curricular planning)
Step 2: Input users' related data. (Fig. 5 Users' data construction)
Step 3: Set the catch target mode, efficiency, screen definition. (Fig. 6 System setting)
Step 4: The user may use a laser pen to point at the item after the setting. In the process the system records the places where the red point passes; afterwards, the mode and efficiency of path replay can be selected (Fig. 7 Browse path remap setting
) and replay the points pointed by the laser pen (Fig. 8 Browse path remap mode).
Step 5: After finishing the test, the system will indicate the track statistic diagram which differentiates the fixation time of a laser pen by colors (Fig. 9 Browse track record diagram) and the system will analyze which item has longer fixation and demonstrate it by ranking in a diagram (Fig. 10 Browse track record diagramtrack).

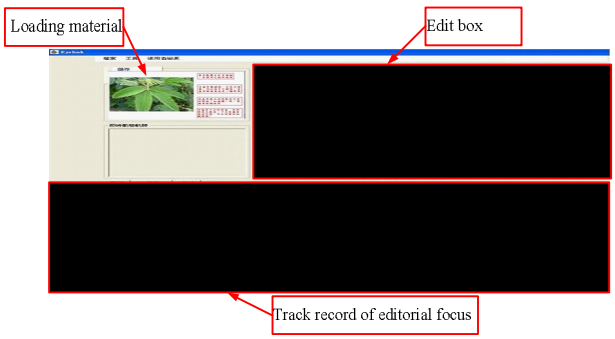

Fig. 4 Curricular planning

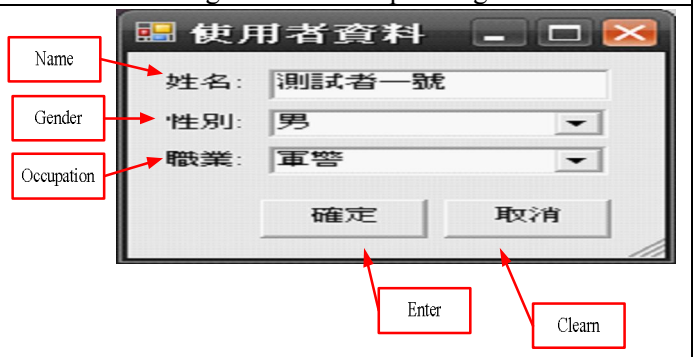

Fig. 5 Users' data construction

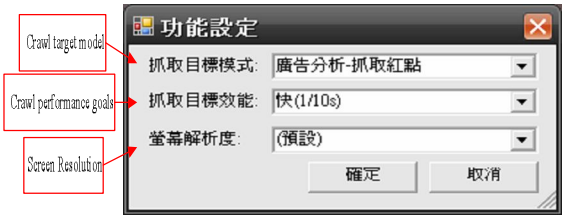

Fig. 6 System setting

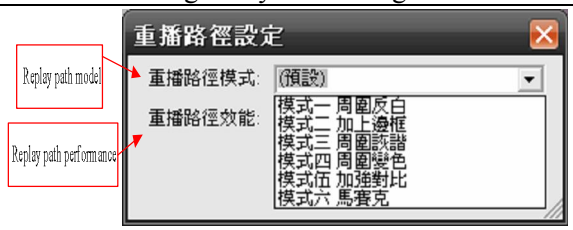

Fig. 7 Browse path remap setting

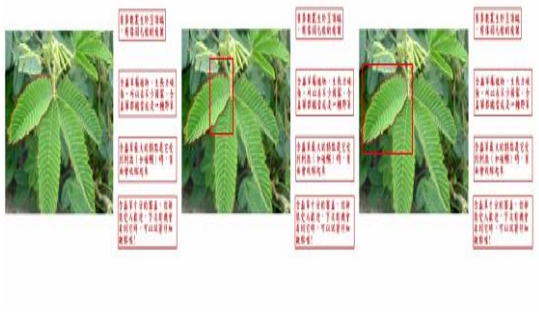

Fig. 8 Browse path remap mode

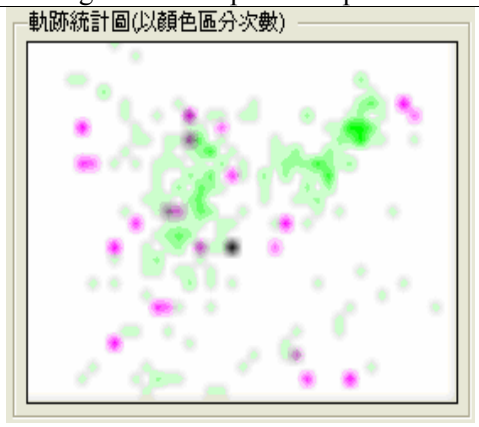

Fig. 9 Browse track record diagram

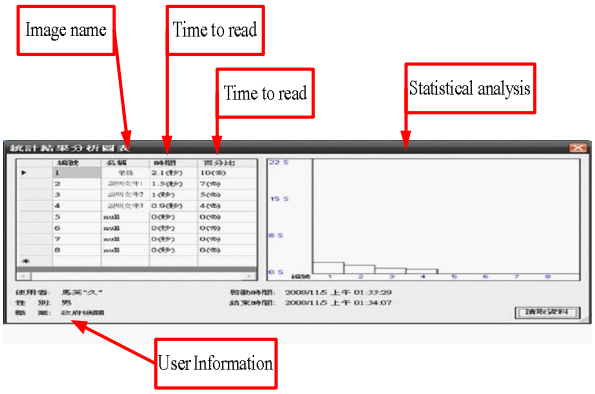

Fig. 10 Browse track record diagram

2 materials are tested by a virtual eye tracker, one is the plant information presented by the plant learning system which presents the plant information completely in a simple arrangement and the other is the collation of the key points and learning objectives in accordance with the teacher's ideas. The learners' watching process was recorded in the virtual eye tracking system which neglects the points with fixation less than 1 second and records the points with fixation at 2 seconds and more. It is found that a learning material with vast information sum fails to let learners focus on learning if the arrangement is not so good whereas a well-edited material enables learners to have better attention. Hence, the record of the material screens the editor identifies important in material edition and that of the learners' reading process are compared. If it is found that learners fail to focus or key parts of the material fail to lure the learners' attention, a message will be sent to the editor so that the material may be improved and optimized.

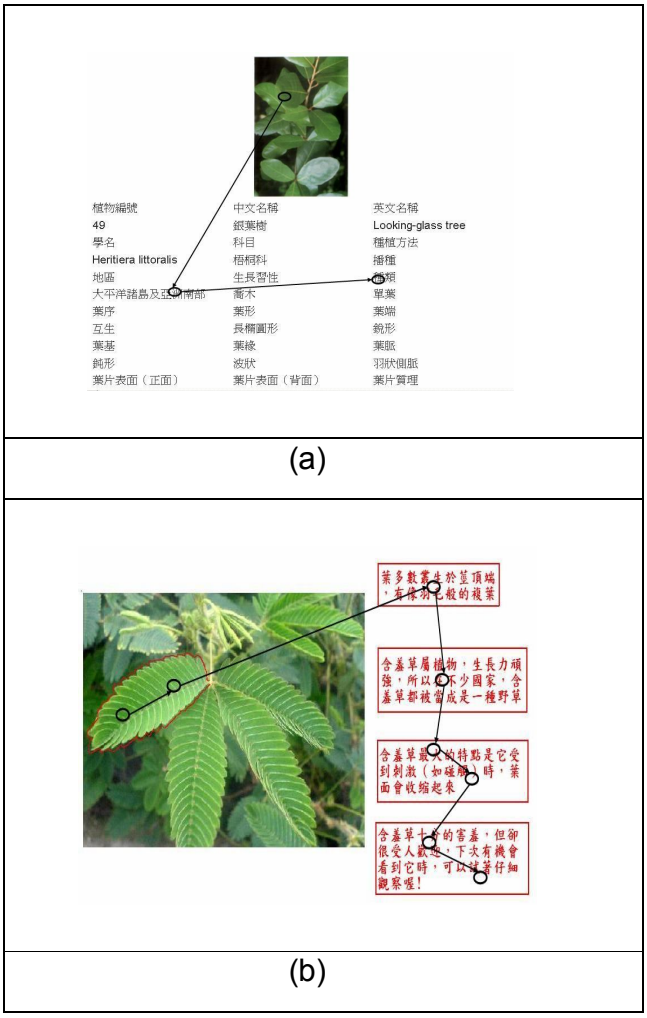

Fig. 11 Executive screen
(a) reading record of browsing webpage (b) reading track record of browsing PowerPoint

4. Conclusions

Materials are deemed as a main tool of instructions as well as the data used in teaching and the key medium to help teachers achieve the instructional objectives. Thus, it is essential for materials to reflect and embody the instructional spirits and objectives and to meet the actual requirements as well. The arrangement of instructional contents can impact not only the instructional schedule, effect, quality and methodological application but also the interest of students for learning curricula. This system offers teachers a platform to inspect the instructional materials. Generally, teachers can only rely on the test results as the indicator to modify the instructional policy; however, this research platform enables teachers to analyze the parts focused by students or learners or the focus degree of learning. A virtual eye tracking system developed by this study is to substitute an expensive eye tracker and to employ the simulation of functions of an eye tracker. Using this system, teachers can realize the students' learning status and the applicability of the arranged digital learning materials and further improve the learning quality by rearranging the material contents.

Moreover, this system is applicable to the advertisement contents design, digital materials design and attention analysis. Through the data of users' browse track, the data are processed by statistics for analyzing the users' reading behaviors.

However, this system fails to compete with the efficiency, accuracy and application range of an eye tracker. It goes without saying that a virtual eye tracker needs to be improved. It is advised that the future studies may focus on the comparison between a virtual eye tracker and an eye tracker and collect more related data to improve the virtual eye tracker.

5. Acknowledgements

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