Abstract—In the next generation of learning environment, a tablet PC with a stylus pen can be a learning tool. In this paper, a framework for learner centered question generation on the tablet PC is proposed. The framework is based on a learner’s actions and context of an expository text. In assisting active learning, three different types of questions can be generated according to the learner’s marking actions. Some associated questions can also be generated based on the type of a question. The generated questions will promote active learning by motivating further self-questionings and markings.

Keywords—self-directed learning; learner centered learning; marking; question generation

I. INTRODUCTION

In the next generation of learning environment, a tablet PC with a stylus pen can be a learning tool. Students read digital textbooks on a tablet PC and make markings. This learning style is one type of active learning in which marking actions lead to self-directed learning. Marking focuses on a certain part of textbook which can affect the succeeded learning. For example, markings could be caused by identifying important concepts or keywords to be memorized, or questioning the descriptions in the text. However, this type of self-directed learning usually is not systematic because markings are ad hoc and the related knowledge is fragmentary. It is necessary to support the learning with assisting facility.

In this study, we look at the possible methods in literature to integrate into this new learning tool. From the viewpoint of note taking, [1] proposes a system to connect conventional textbook and digital world. In the system a user can extract a passage from a textbook with a digital pen and store it in a computer system. The methods of question-driven reading are facilitated in the system. The effectiveness of question generation has been studied in experiments [2] and positive conclusions have been discussed. Ref. [3] focused on mapping technique in expository text and discussed the effect of recall practice. An expository text consists of answers to questions and explanations of new knowledge. For the mappings, the authors in [3] proposed seven basic relationships, i.e., example, property, compare/contrast, temporal, causal, enabling, and conditional. The concept map technology is similar to the mapping and [4] proposed question generation using concept map. From the viewpoint of fill-in-blank type question generation there are studies using natural language technology [5] and another study using learning activities [6]. From the viewpoint of text structure the studies indicated that the consciousness of text structure especially in expository text had a good effect on the comprehension of the contents [7].

In our proposed learning tool, we will try to integrate these methods. However, these methods should not disturb the spontaneous feature of active learning. In other words, the support can be regarded as indirect control of learning. In this paper, a learner centered question generation framework is proposed. The framework is based on a learner’s actions and context of an expository text. The actions could be writings or markings. In the proposed framework, three basic types of questions can be generated according to these actions. Some associated questions can also be generated based on the type of a question.

The remaining of the paper is organized as follows. Section II introduces the learning model. Section III presents the question generation framework. Section IV explains the system design and Section V concludes and discusses future work.

II. THE LEARNING MODEL

A learning model for the proposed framework is shown in Figure 1. A learner is located at the center and takes an initiative to reading and marking on a digital textbook. The markings are monitored and the information in context will be translated into questions and arranged in semi-structured notes. These questions will be asked later to the learner. The questioning stimulates the learner to further self-questionings and markings. On the other hand, the semi-structured information as a note can be edited by the learner at the learner’s convenience.

Self-questionings can be roughly classified in three types, i.e., what-type, how-type, and why-type. A what-type

![Figure 1. The Learning model](image-url)
question is triggered by new word(s) at a shallow level or incomprehensible descriptions at a deeper level, such as the author’s intentions. A how-type question is triggered by some gaps between the author’s descriptions and the reader’s understandings, such as an assertive sentence or a logical leap. A why-type question is similar to that of how-type, but requires a cause or reason to an effect. On the other hand, a how-type question requires more concrete explanations of procedures.

In the learner centered learning model, a learner can take initiative to the learning. Even though the questioning and note-taking can be initiated by others, the questions and notes are based on the learner’s markings. Thus it keeps as an active learning model. However, if the learning is controlled completely by the learner’s markings the learning might result in incomplete or biased knowledge of the text. Therefore, it is necessary to ensure that the questioning will cover predefined knowledge in the textbook.

III. QUESTION GENERATION FRAMEWORK

A question generation framework consists of templates and knowledge graphs. The framework ensures to cover whole knowledge in a textbook and to promote the learner centered learning. In this framework the knowledge graph and template assume that a textbook is an expository text which consists of answers to questions and explanations of new knowledge to the learner. So a learner has to identify questions and answers described by the author or to declare their own questions and the answers in the text.

Figure 2 shows an example of a knowledge graph. In the knowledge graph, a circle means a part of description in a textbook which is extracted by a marking or predefined by the author (shown as “D”). A link means an association or relation between two descriptions (shown as “A”). In an expository text these associations are sequence, cause and effect, problem and solution, comparison, and so on. Associations are logical structure which is represented by the author explicitly or implicitly. Usually in order to find the associations there are signal or clue words, e.g. “such as”, “first”, “since”, “problem is”, and so on.

The solid line means learner-focused and learner-marked descriptions. The procedures of question generation for fill-in-the-blank type are: (1) Select a template based on the question type; (2) Substitute the words for each part; (3) Determine which word(s) to be blanked out. The templates corresponding to each question type are shown in Table I. The type means a question type and will be defined by marking symbols. The template and text includes terminal symbols and non-terminal symbols. A non-terminal symbol is substituted by an extracted text to serve as the subject of a question or an answer. In the templates, the terminal symbols are “is”, “because”, or certain verbs.

A learner-focused question is constructed simply by blanking the answer in the sentence which bares the markings. On the other hand, a predefined question and answer can be formed according to the learner-focused question. This means a question generation priority will be given to the learner-focused question.

Each question has a role to promote the learner centered learning. There are four roles to the learner-focused knowledge, i.e., reinforcing, enhancing, deepening, and widening. For example, the combination (A12, D1, D2) means learner-focused knowledge which will be generated as a question. In this case D1 is a question part and D2 is an answer part. D4 is a child of D2, so the learner-focused knowledge will be extended by a question generated by (A24, D2, D4). D5 is a sibling node of D3, so the learner-focused knowledge will be enhanced by a question generated by (A13, D1, D3). D6 is a neighbor of D3, so the learner-focused knowledge will be expanded by a question generated by (A16, D1, D6).

IV. SYSTEM DESIGN

The system structure is shown in Figure 3. The tablet PC communicates with a LMS (learning management system). A learner interacts with software agents, i.e., the personal agent and the pedagogical agent through the tablet PC. The personal agent monitors the learner’s actions. It extracts the markings as text and informs the pedagogical agent through respective communication managers. The pedagogical agent will translate the information into quiz questions which are
stored in the database of the LMS. The quiz question translation is based on the learner model, production rules, and pedagogical knowledge. These quiz questions will be presented to the learner at appropriate time. Every learner can take their own quizzes through a web browser. The learners are managed in the LMS. The LMS also manages digital texts and context information, e.g., words, phrase, sentence, logical relation among them, author’s intention, problems and answers, and so on.

A learner can mark any part of a digital text on a tablet PC with a stylus pen. These markings include encircling or underlining, connecting with lines, writing simple marking symbols. Hence, the markings could be ambiguous, but the software agent will detect the learner’s intentional part by using context knowledge. Furthermore, the software agent analyzes why the learner marks these parts based on a marked symbol. The intentional part can be called a question text part or an answer text part according to the symbols.

The steps to analyze an encircling are: (1) Detect starting point of encircling of a stylus pen; (2) Calculate max/ min coordinates of the oval vertically and horizontally; (3) Compare the coordinates of starting point with max/min coordinates; (4) Determine the reasonable rectangle area; (5) Extract an intentional part of text based on the rectangle area, symbols, and context information. The symbols could be: ? / ! (question / answer), wt (what-type question) followed by a question mark, wy (why-type question) followed by a question mark, hw (how-type question) followed by a question mark, and a directed line which is detected by comparing the coordinates of the starting point and the end point. A software agent monitors these markings and detects an intentional part or recognizes the type of each symbol.

Figure 4 demonstrates a user interface on a tablet PC and the generated question based on the proposed framework. The question mark indicates a description which a learner didn’t understand and the exclamation mark indicates an answer description found by the learner. In this case the relation between the two descriptions is given explicitly as a directed link. The encircling is ambiguous but the answer part is extracted correctly.

V. CONCLUSION

In this paper, a new learning tool for the next generation learning environment, i.e., a tablet PC with a stylus pen was advocated and the technology enhanced learning framework was proposed. The framework is based on a learner’s actions and context knowledge of an expository text. The actions include writing and markings which are caused by self-questionings while reading the text. After the learner identifies new concepts or finds an answer to a question on the expository text the learner will mark it on the text. In the proposed framework, three different types of questions can be generated according to these markings. Some associated questions can also be generated regarding a type of question generated by the markings. These generated questions will promote active learning by motivating further self-questionings and markings. The future work is to fully implement the system and evaluate the effectiveness of its use in motivating learner centered active learning.

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