A Web-based Model of Student Profile Using CRM Technology

Chan Wai Nelson
Department of Computing, Hong Kong Polytechnic University
E-mail: csnchan@comp.polyu.edu.hk

Andy Tsang
Department of Computing, HK Institute of Vocational Education (Kwai Chung)
E-mail: cwtsang@vtc.edu.hk

This paper describes a prototype of a Web-based model using CRM (Customer Relationship Management) technology. The Web-based model will provide a learning profile for individual student to keep track of his/her problem-based learning skills. The objective of the model is to allow students to access the FAQ (Frequently Asked Question) module using the chat room facility for a given problem. The problem is designed so that only a certain number of the Frequently Asked Questions can provide hints or partial answers to the solution of the problem. The prototype will track all activities generated by the student for each problem. Subsequently, teacher can access the student profile via the prototype to reveal the learning behavior of individual students so as to enhance the teaching quality and problem-based learning strategy.

1. Introduction

With the increasing number of students enrolled per course, classical question-and-answer activities appear to be relatively inefficient [4]. Posting teaching materials onto the Web appears to be ineffective because students still have to go through those materials that they already understood [1]. To cope with the information era of the 21st century, Web-based teaching materials require substantial intelligence deemed to be essential [3].

This paper intends to outline the framework of a Web-based model that will provide an interactive learning environment [6]. This model aims to assist the teacher in handling a relatively large number of students' questions as well as providing a platform for problem-based learning. As a consequence, students can benefit from problem solving, directed learning, creative thinking, and collaborative learning skills [7]. There are a number of advantages of this model as listed below:

- Students learn at their own paces.
- Students will not feel being left alone.
- Students do not have to go through those materials that they already understand.
- Students receive real-time response from the system.

2. Framework

The model consists of a number of components that are developed in a Web environment [2]. These are a Chat Room component, a FAQ Manager component, a Chat Room Agent component, a Screen Agent component and a Student Profile Agent component. Operations are simple and straightforward. During a tutorial session or question-answer session, students use the chat room to type in questions that they do not understand. Questions will be limited to definitions, topics, methods and procedures. Once the question is entered, the Chat Room Agent will parse the typed question and analyze it. If the analysis is meaningful, then it will invoke the FAQ Manager to search for answer(s). The answer(s) will be automatically routed back to the chat room where this question was originated. If the analysis is not meaningful, the Chat Room Agent will request further clarification from the student. If the FAQ Manager fails to find an appropriate answer after clarification from the student, it will inform the Chat Room Agent. The Chat Room Agent will then send a message to the teacher for attention. The teacher may at his option, use the chat room to communicate with the student or invoke the Screen Agent to transfer necessary information to the student. In each case, the Student Profile Agent will record the activity that will be used later for analysis to explore the students' learning behavior. The overall architecture is illustrated in Figure 1.
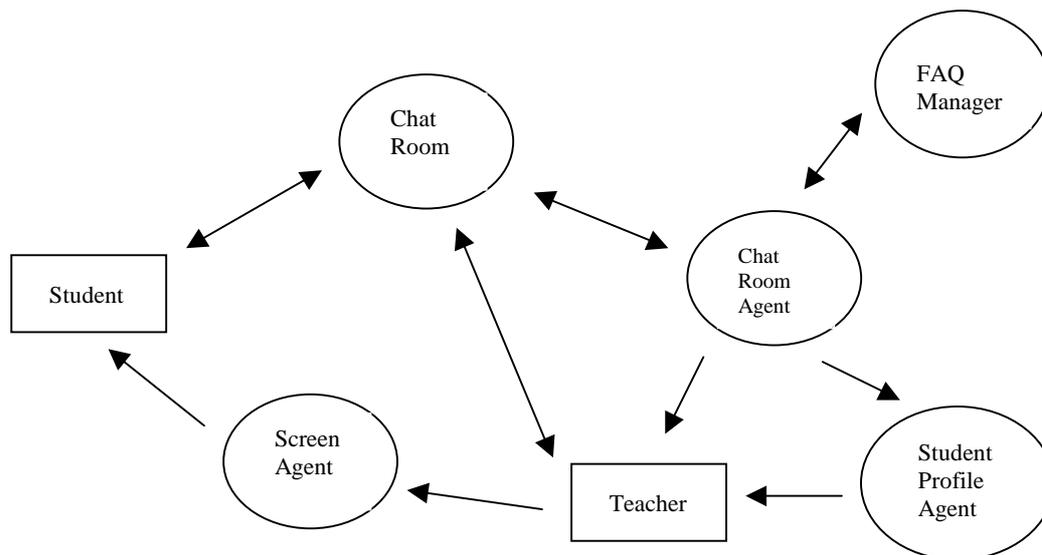

Figure 1. Framework of the eLearning Model

3. Components of the eLearning Model

The architecture provides online interaction between students, teaching materials and the teacher. In order to be portable to various platforms, Java is selected as the backbone language for the construction of most of the components. Among these five components, the most critical components are the Chat Room Agent component and the FAQ Manager component.

3.1 Chat Room Agent

The Chat Room Agent serves the function of a parser. It attempts to parse the input text typed by the student into a number of meaningful tokens. In other words, any noise contained in the input

text will be identified and removed first. The Chat Room Agent assumes the following possible semantics of an input text related to certain course materials:

- A single item is being asked;
- A number of related items are being asked;
- A number of disjoint items are being asked;
- Any combination of the above.

By further narrowing down the meaning of an item, it can be classified as a <definition>, a <method> or a <topic> and nothing else. The following examples illustrate the classification of an item:

Table 1. Classification of an Item

Question	Classification
What is a notebook?	<definition>
Please explain mainframe and PC.	A number of related <definition>
How integer is stored?	<method>
Tell me something about deadlock and mutual exclusion.	A number of disjointed <definition>
How number is stored?	<topic>
Describe Shortest Job First algorithm.	<method>
Tell me something about ABC.	Unidentified item
Why AB + C = (A+C) (B+C)	Unidentified item

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If the Chat Room Agent is unable to parse the input text, then it will repeatedly attempt to seek clarification from the student. Once the input text has been parsed successfully, the FAQ Manager component will be called for subsequent searching operations. For each successful inquiry, the average turn-around time is expected to be less than three seconds.

3.2 FAQ Manager

The FAQ Manager will search for answer(s) from the FAQ database based on the information sent by the Chat Room Agent. The FAQ database contains answers and is developed and maintained by the teacher. The information sent by the Chat Room Agent contains at least two important tokens. The first token is the item itself, the second token is a code associated with the classification of the item. The value of the code can be M <method>, T <topic>, or D <definition>. After performing the search, the FAQ Manager will return either one of the following items to the Chat Room Agent:

- a description of the item <definition>; or
- a description of method and/or a file <method>; or
- an URL address <topic>; or
- a null string.

It is expected that students should not inquire on more than three items per question, otherwise it will deprive the objective of this model. Figure 2 depicts the operations of the FAQ Manager.
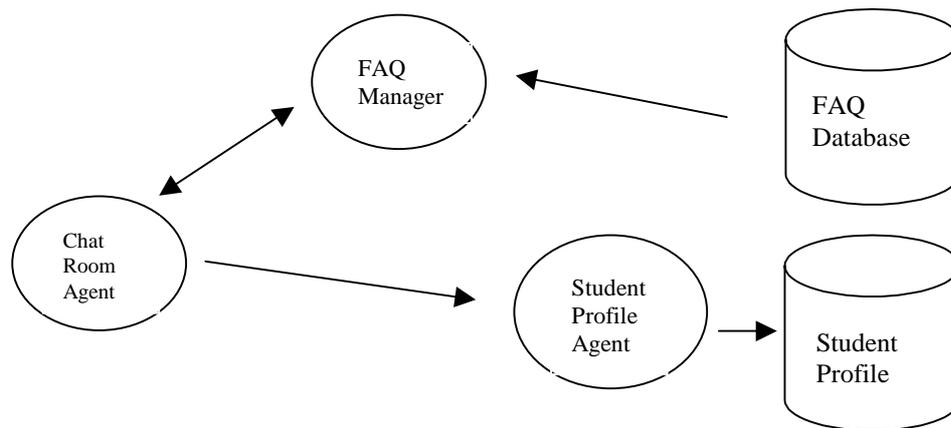
Figure 2. FAQ Manager searches for answer(s) from the FAQ database.

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If the search is unsuccessful, the teacher will be informed. Regardless of the search is successful or not, the Chat Room Agent will inform the Student Profile Agent about the question (typed by student) and the result of the search.

3.3 Student Profile Agent

There are two functions to be associated with the Student Profile Agent. The first function is to record student activities. Each question as typed by the student and together with the result of the search will be passed by the Chat Room Agent to this component. Upon receiving the information, the Student Profile Agent will store the information in the Student Profile database. The second function is to retrieve student activities from the Student Profile database when requested by the teacher. In this case, the teacher must provide the student number and select the date of activity as supplied by the Student Profile Agent.

3.4 Screen Agent

The Screen Agent is optional and to be used by the teacher only. It serves a single function – to 'push' the information as selected by the teacher to a student's screen. There are two pieces of information that can be pushed. The first is the current teacher's screen and the other is a file selected by the teacher. The purpose of using the Screen Agent is when the teacher would like to draw a student's attention to certain information based on a particular problem. This may happen, for example, if the information is lengthy and has already been stored in a file or in some HTML page.   In this case, the teacher simply selects the relevant file or the HTML page and then 'pushes' it to the student's screen.

4. Problem Solving

The eLearning model treats each question as an input text. To realize the usefulness of the Student Profile, it is important to understand the interaction between a given problem and the Student Profile. Consider, as an example, a text of "110" being displayed by a CRT of a PC; students are

required to give all possible attributes and computer storage representations using the FAQ module. Initially, the FAQ is loaded with more than 1,000 solutions of different types of problem. In particular, the solution to this problem has already been mined in the FAQ by the teacher. Table 2 highlights the possible hints/answers stored in the FAQ to this problem.

Table 2. Type of possible hints/answers to the problem

FAQ No.	Attribute	Representation
10	Integer	16-bit, 32-bit
150	IBM Floating-point	32-bit, 64-bit using 16 as the exponent of its characteristic
151	IEEE Floating-point	32-bit, 64-bit using 2 as the exponent of its characteristics
300	ASCII character	8-bit character encoding system .
310	EBCDIC character	8-bit.character encoding system
400	Boolean	1 = True, 0 = False
320	Unicode character	16-bit character encoding system
120	Binary	Binary digit using 2's complement system

It should be noted that each attempt made by a student using the FAQ will be recorded in the Student Profile. Prior to solving each problem, students are advised to minimize their FAQ inquiries. The FAQ No, is used to reflect the learning behavior of a student. For a hypothetical case, the sequence of FAQ number of a student as captured in the Student Profile can be nil. One of the critical success factors of using the FAQ is that the solution should not be directly obtained. It is expected that students must at least carry out some prior analysis work or literature search. After the problem is graded, the learning behavior can be used to compare against the mark in order to enhance the teaching quality and strengthen the problem-based learning strategy. Figure 3 illustrates how to remedy the problem-based strategy by introducing more related hints/answers into the FAQ.

Computer storage

Numeric   Character   Boolean

1. Integer   1. ASCII   .
2. Floating-point   2. EBCDIC
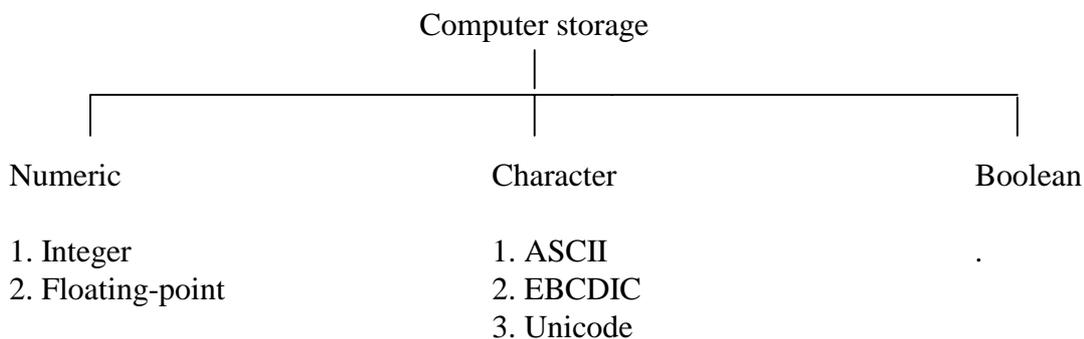   3. Unicode

Figure 3. Hierarchy of an item – computer storage.

From the student point of view, if the student did not analyze the problem but simply uses the eLearning model directly, he/she might not be able to derive a complete solution. For example, if

he/she simply searches for ASCII code, integer and floating-point, his/her answer appears to be incomplete. A better search list might consist of items such as the number systems, computer storage and character code. For the number system, the eLearning model will provide some general information about the binary number system, octal number system, decimal number system, hexadecimal number system and floating-point number system. For the character code or alphanumeric code, the eLearning model will provide some general information about ASCII code system, EBCIDIC code system and Unicode system. Upon receiving the general information, the student still has to consolidate and plan for another search list. The result of the second search list should provide the student with more in-depth information about individual number systems and character code systems. Finally, the student may arrive at the following conclusions:

Table 3. Possible internal storage structures for numeric value 101 and Boolean 101

External Representation	Equivalent Decimal Value	Internal Storage Representation (32 bits)
Binary	5	0000000000000000 ⋯ 0000000101
Octal	65	0000000000000000 ⋯ 0001000001
Decimal	101	0000000000000000 ⋯ 0001100101
Hexadecimal	257	0000000000000000 ⋯ 0100000001
IBM floating-point	101	01000001110010100 ⋯ 0000000000
IEEE floating-point	101	01000010110010100 ⋯ 0000000000
Boolean	Not Applicable	Not Applicable

Table 4. Possible internal storage structures for ASCII 101 and EBCDIC 101

External Representation	Equivalent Decimal Value	Internal Storage Representation (three bytes)
ASCII	101	001100010011000000110001
EBCDIC	101	111100011111000011110001

It is important to note that the eLearning model does not directly provide a solution of the above problem. Students have to go through some thinking and calculating processes before obtaining the conclusion.

5. Data Mining

The discovery of interesting association relationships among the student profile records can help enhance the teaching quality and strengthen the problem-based learning strategy. Student studying behavior can be obtained by finding association rules between their FAQ inquiries. For instance, if students are inquiring FAQ No. 10, how likely are they to also inquiring FAQ No. 150? Such information can help teachers:

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5.1 Formal Model

To be able to draw conclusions on individual learning behaviour, teaching quality and relationship between questions, the following formal analysis is provided.
Let $I = \{q_1, q_2, \ldots, q_m\}$ be a set of FAQ questions.
Let D be a database of transactions. Each transaction t is represented as a binary vector, with $t[k] = 1$ if t asked the FAQ question q_k, and $t[k] = 0$ otherwise.

Let X be a set of some questions in I. We say that a transaction t satisfies X if for all questions q_k in X, $t[k]=1$.

By an association rule [5], we mean an implication of the form $X => q_j$, where $X \subset I$, $q_j \subset I$ and $X \cap qj = \phi$.
The rule $X => q_j$ holds in the transaction set D with the support($X => q_j$) that is the percentage of transactions in D containing $X \cup q_j$. This is taken to be the probability, $P(X \cup q_j)$.
The rule $X => q_j$ has confidence confidence($X => q_j$) in the transaction set D, where the confidence is the percentage of transaction in D containing X that also contain q_j. This is taken to be the conditional probability, $P(X\backslash q_j)$. That is,

$$\text{support}(X => q_j) = P(X \cup q_j) \qquad \text{a measure of the rule's strength}$$
$$\text{confidence}(X => q_j) = P(X\backslash q_j). \qquad \text{a measure of statistical significance}$$

Association rules are considered interesting if they satisfy both a minimum support threshold and a minimum confidence threshold.

Table 5 is an example that shows the transaction database and finds all association rules in the form of $A => B$ with minimum support 50% and minimum confidence 50%.

Table 5. A transaction database.

Transaction ID	FAQ asked
10030	q1, q4
10020	q2, q5, q6
10010	q1, q3
10040	q1, q2, q3

We have 2 interesting association rules:

support($q_1 => q_3$) = $P(q_1 \cup q_3)$ = (no. of transaction containing $(q_1 \cup q_3)$ /
total no. of transaction in the database)*100%
= (2/4)*100%=50% >= the given minimum support threshold

confidence($q_1 => q_3$) = $P(q_1 / q_3)$ = (no. of transaction containing $(q_1 \cup q_3)$ /
no. of transaction containing q_1)*100%
= (2/3)*100%=66% >= the given minimum confidence threshold

Therefore, q1 => q3 (50%, 66.6%) is deemed an interesting association rule.

$$support(q_3 \Rightarrow q_1) = P(q_3 \cup q_1) = (\text{no. of transaction containing } (q_3 \cup q_1) /$$
$$\text{total no. of transaction in the database})*100\%$$
$$= (2/4)*100\% = 50\% \geq \text{the given minimum support threshold}$$

$$confidence(q_3 \Rightarrow q_1) = P(q_3 / q_1) = (\text{no. of transaction containing } (q_3 \cup q_1) /$$
$$\text{no. of transaction containing } q_3)*100\%$$
$$= (2/2)*100\% = 100\% \geq \text{the given minimum confidence threshold}$$

Therefore, $q_3 \Rightarrow q_1$ (50%, 100%) is deemed an interesting association rule. With this information, conclusions can be drawn on individual learning behavior, teaching quality, and relationship between questions.

6. Conclusions

The success of teaching effectively and learning efficiently requires significant effort from both sides, namely the teacher and the student. The Student Profile model can provide sufficient effective quality feedback about the teaching and students' learning behavior if

- the problem has been carefully designed with the hints/answers in the FAQ;
- a suitable number of problems is to be given to students as part of their assessments; and
- each problem is to be handled during tutorial session so that individual learning behaviour can be recorded with least bias.

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