



Applying hybrid data mining techniques to web-based self-assessment system of Study and Learning Strategies Inventory

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ABSTRACT

Traditional assessment tools, such as “Learning and Study Strategy Scale Inventory (LASSI)”, are typically pen-and-paper tests that require responses to a multitude of questions. This may easily lead to student’s resistance, fatigue and unwillingness to complete the assessment. To improve the situation, a hybrid data mining technique was applied to analyze the LASSI surveys of freshmen students at Tamkang University. The most significant contribution of this research is in dynamically reducing the number of questions while the LASSI assessment is proceeding. To verify the appliance of the proposed method, a web-based LASSI self-assessment system (Web-LSA) was developed. This system can be used as a guide to determine study disturbances for high-risk groups, and can provide counselors with fundamental information on which to base follow-up counseling services to its users.

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1. Introduction

1.1. Motivation

Universities and colleges in Taiwan have recently acknowledged the importance of student affairs and have actively promoted counseling on career exploration, self-understanding, and interpersonal behavior for students. Hence, the student affairs office often plays a vital role in counseling students where they live and study. For example, the Consultation and Guidance Division of Student Affairs Office at Tamkang University could conceivably assist more than 27,000 students in the assessment of their learning and study strategies, personality characteristics, career interests, etc. and provide follow-up analyses and other services. Unfortunately, the number of available counselors in each school to provide these services is very limited. Conversely, the increased number of questions in a survey negatively influences the willingness of the participants to answer. Therefore, determining significant patterns in the scales and items in traditional assessments is essential to reducing the workload of counselors and improving the cooperation of its participants.

As computers and network-related technologies rapidly and substantially improve, web-based testing (WBT) is becoming a common and effective type of assessment in different educational

settings (He & Tymms, 2005; Sheader, Gouldsborough, & Grady, 2006; Wang, 2007; Wang, Wang, Wang, Huang, & Chen, 2004). Although the web-based LASSI by Weinstein et al. is available at the web site developed by H&H Publishing Company (Weinstein & Palmer, 2002), its online completion is nonetheless time-consuming.

1.2. Objectives of the study

The aims of this paper are:

- (1) To propose a hybrid data mining technique to examine the important characteristics of study strategy scales and their inter-relationships. By using fewer questions and thereby promoting better cooperation, learning problems will be predicated and information on study disturbances of high-risk groups will be readily provided.
- (2) To assist counselors and students to more efficiently use the LASSI assessment. A web-based Learning and Study Strategy self-assessment system (Web-LSA) was developed based on the rules discovered by the hybrid data mining approach. This system can be used as a pre-achievement measure for students participating in programs or courses focused on learning strategies and study skills through the Internet, and as a timesaving support tool for counselors.

The remainder of this paper is organized into five sections; Section 2 describes the background knowledge of “Learning and

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Study Strategy Scale Inventory" (LASSI) and related data mining techniques. Section 3 introduces the proposed hybrid data mining approach. Section 4 is the comparative results of the experiment and the performance evaluation. Section 5 is the implementation of web-based LASSI self-assessment system. Finally, the conclusions and future works are discussed in Section 6.

2. Background knowledge

2.1. Learning and Study Strategy Scale Inventory for university students

The Learning and Study Strategies Inventory (LASSI) was proposed by Weinstein (Weinstein, 1988a, 1988b). It is a diagnostic and prescriptive measure. The original version of LASSI is a 10-scale, 80-item assessment of students' awareness and use of learning and study strategies related to skills, will and self-regulation components of strategic learning (Weinstein & Palmer, 2002). In this paper, a modified version was considered, an 11-scale, 87-item LASSI assessment, as shown in Table 1, more frequently used in Taiwan.

Resources for this research were gathered from the LASSI from university freshmen, provided by the Consultation and Guidance Division of Student Affairs Office at Tamkang University. Results have provided students with a diagnosis of their strengths and weaknesses and suggestions have been given on enhancement through educational interventions, such as learning and study skills courses. The LASSI is scored using the Likert Scale's five-point scale; "Not at all typical" scored one mark, "Not very typical" scored two marks, "Somewhat typical" scored three marks, "Fairly typical" scored four marks, and "Very much typical" scored five marks. Because the reverse-scoring item reversed the scores, "Not at all typical" scored five marks; "Not very typical" scored four marks, and so on. Most students completed this assessment in approximately 25–30 min. The LASSI scales can be applied separately or as a whole.

For the sake of convenience, the percentage rank norms of LASSI for the average university student have been simplified as Table 2. Percentage ranks above 50 signify "good" in study strategies while below 50 signify "poor". Instructors can refer to the students' scores on each LASSI scale in the table to diagnose the students' situations in the related learning and study strategies.

2.2. Data mining technology

The data mining technology is concerned with the discovery and extraction of latent knowledge from a database (Chang, Healey, McHugh, & Wang, 2001). Many algorithms are developed, proposed, and applied: the decision tree, clustering, sequence

clustering, association rule, Naïve Bayes, regression, neural network, etc. Recently, data mining technique has become more popular and is now being frequently used in real-world applications, such as learners' behavioral patterns and usage rules in interactive educational systems from a computer system's access logs. With data mining, essential activities can be captured, learner behaviors determined and interpreted in the context of learning styles and goals. Given that these tools show different calculative methods and presentable patterns, decision tree and association rules are selected to further explain data mining.

2.2.1. Decision tree

A decision tree is based on the methodology of tree graphs and can be considered one of the more simple inductive study methods (Quinlan, 1993, 1996; Stuart & Peter, 1995). Even if the user lacks any statistical knowledge, he or she can use a decision tree to analyze specific behavior (see Fig. 1 for an example of a decision tree). A decision tree can be easily converted into rules. However, if it becomes too complicated or too huge for decision-making, trimming some of its leaves or branches may become necessary in order to improve its effectiveness. Of all the calculative methods, ID3, C4.5 (Cheng, Fayyad, Irani, & Qian, 1998; Quinlan, 1993; Weiss & Indurkha, 1996), CART (Breiman, Friedman, Olshen, & Stone, 1984) and CHAID (Magidson, 1993) are the most well known.

2.2.2. Association rule

In data mining, association rule analysis was used to discover elements that co-occur frequently within a data set consisting of multiple independent selections of elements (such as purchasing transactions), and to discover rules, such as implication or correlation, which relate co-occurring elements (Agrawal, Imielinski, & Swami, 1993; Agrawal, Mannila, Srikant, Toivonen, & Verkamo, 1996; Agrawal & Srikant, 1995; Han, Pei, & Yin, 2000; Hipp, Güntzer, & Nakhaeizadeh, 2000; Park, Chen, & Yu, 1997; Srikant & Agrawal, 1996). Brin, Motwani, Ullman, and Tsur (1997) applied association rule learning to purchase data with the goal of identifying cross-selling opportunities, it was a well-known Market Basket Analysis. There are many other interesting areas in which it can be applied, such as analysis of credit card purchases, analysis of telephone calling patterns, identification of fraudulent medical insurance claims and analysis of telecom service purchases.

A typical association rule is an implication of the form:

$A \rightarrow B$ (support)(confidence)(lift), which means that the presence of itemset A implies the presence of itemset B with certain level of support, confidence and lift. The support of the rule means the frequency of itemset A and itemset B coincide in all of the transactions, which can be shown as

$$\text{support}\{A \rightarrow B\} = \frac{\text{Transactions of } \{A \cap B\}}{\text{Total transactions}} \quad (1)$$

The confidence of the rule is the intensity and reliability of B acts upon the association rule, that is, the percentage of B in the transactions of A :

$$\text{confidence}\{A \rightarrow B\} = \frac{\text{support}\{A \cap B\}}{\text{support of } A}, \quad (2)$$

where $\text{support}\{A \cap B\}$ is the percentage of transactions that involve both A and B .

Lift shows the association between A and B . The formula of lift is as follows:

$$\text{lift}\{A \rightarrow B\} = \frac{\text{confidence}\{A \rightarrow B\}}{\text{support of } B} \quad (3)$$

The significance of an association rule is judged based on support and confidence, which must always be greater than the threshold. In other words, the bigger lift is more valuable. The results indicate

Table 1
The LASSI scales

LASSI scales ^a	Included item numbers ^b
Attitude (ATT)	13, 16, 34, 40, 46, 64, 81
Motivation (MOT)	9, 12, 26, 30, 37, 44, 51
Time management (TMT)	3, 20, 32, 38, 43, 53, 61, 68, 87
Anxiety (ANX)	1, 8, 23, 28, 49, 52, 58, 82
Concentration (CON)	5, 10, 35, 39, 41, 50, 56, 63
Information processing (INP)	11, 14, 21, 29, 36, 42, 62, 70, 83
Select main idea (SMI)	2, 7, 55, 67, 71, 84
Study aids (STA)	6, 17, 22, 45, 48, 57, 85
Self-testing (SFT)	4, 15, 19, 24, 27, 33, 60, 65, 86
Test strategies (TTS)	18, 25, 31, 47, 54, 59, 66, 69
Solving skill (SOS)	72, 73, 74, 75, 76, 77, 78, 79, 80

^a Each scale of study strategy abbreviated as 3-letter codes.

^b Underlining number represents a reverse-scored item.

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