A PROPOSED METHOD FOR GENERATING QUESTION TESTS BASED ON PRESCRIPTION DRUG NAME SIMILARITY

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Abstract: An educational program aimed at orienting medical staff on proper prescription drug use needs to be implemented to avoid medical errors. Presently, pharmacists are guided by information provided in package inserts. However, these inserts are not suitable educational materials because their descriptions are usually very complex. A huge effort is needed to create educational materials for each of the 20,000 prescription drugs currently used in Japan. Therefore, it is necessary to develop a learning support system with functions that can generate educational materials automatically from a drug information database. Here, we propose a method for generating multiple-choice tests that allows students to associate brand and generic drug names based on similarity.

1 INTRODUCTION

The Japan Council for Quality Health Care has gathered many near miss cases which have been reported by pharmacists, including confusing prescription drug amount, standard unit, dosage format, as well as other mix-ups (Japan Council for Quality Health Care, 2010). Studies indicate that many pharmacists consider these errors to arise from a lack of medical knowledge, technique, and education. Furthermore, these errors are caused by medical staff lacking the necessary medical knowledge, and include pharmaceutical students, new pharmacists, and returning pharmacists. Thus, proper education is necessary to ensure medical safety. The Ministry of Health, Labor, and Welfare has set up a specific agenda regarding the practical training of pharmaceutical students (Health, Labour and Welfare Ministry, 2007). In this report, students were required to have knowledge and proper prescription drug technique.

Prescription drug information is commonly detailed in package inserts, and includes information related to dosage, efficacy, and cautions. By law, pharmaceutical companies are obligated to append package inserts on all drugs. While pharmacists obtain information about a drug from package inserts, these documents are not suitable educational materials since descriptions are generally complex. Yet, generating educational materials for each drug becomes an enormous task as there are over 20,000 drugs presently used in Japan. The number of drugs is expected to increase as the number of recommended generic drugs increases. Therefore, it is necessary to develop a system whereby educational materials are generated automatically. Figure 1 shows the configuration of proposed system. This system generates the educational materials based on drug information, learning records and near-miss cases. Learners gain the knowledge concerning drugs from them.

Figure 1: Learning supporting system for pharmacists.

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As part of the educational materials used for this method, we focused on brand and generic name associations, with generic names categorized by pharmaceutical company and brand names by active ingredient. Although package inserts typically go by brand name, pharmacy students learn drug information by generic name. Therefore, to associate a brand name with a particular piece of information, pharmacists must first learn to associate brand names with generic names. In this report, we propose a method for generating multiple-choice tests which facilitate brand and generic name associations.

With regard to multiple-choice tests, question difficulty often depends on answer choice similarities. Likewise, the method proposed here focuses on prescription drug name similarity. Given that such similarity creates confusion, students often struggle to find the correct answer in multiple-choice tests. Furthermore, some brand names are derived from generic names. These drug names, however, are easily identified if presented to students in a question format. Thus, question difficulty can be controlled by using prescription drug name similarity. To assess the relationship between question difficulty and drug name similarity, we experimented with questions generated automatically by a computer, and evaluated the proposed method by analyzing input logs obtained from each learning activity.

2 GENERATION OF PRESCRIPTION DRUG NAME TEST

In this report, we used data previously presented by Tsuchiya (F. Tsuchiya, 2008). Target prescription drugs included 15,014 brand names and 1,402 generic names, all consisting of a single active ingredient. We notice that the medicine names are presented by Japanese characters although we described the medicine names by alphabet in this paper.

A multiple-choice test was generated as shown in Figure 2. The test consisted of a computer generated question and brand names were provided as answer choices. Only one brand name corresponded to the active ingredient (i.e., generic name) in the question. Thus, each question had only one possible answer, and students were permitted to move on to the next question if they could not answer it.

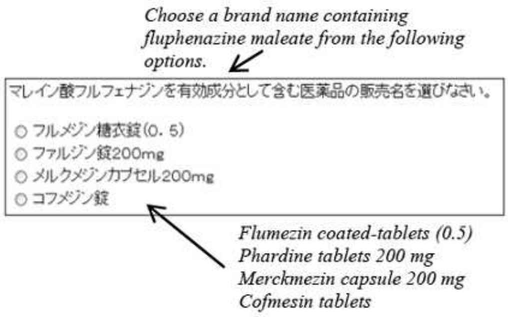

Figure 2: Computer generated sample question.

2.1 Selection of Prescription Drug Names based on Similarity

Question difficulty in multiple-choice tests is usually based on answer choice similarities. Likewise, for the method devised here, question difficulty was controlled by brand and generic name similarity. The similarities between four prescription drug names are shown in Figure 3.

Student's level of understanding can be gauged with questions that rely on drug name similarity. In the study presented here, if knowledge regarding a drug's name was lacking, students tended to choose the wrong answer given its similarity to the correct answer choice.

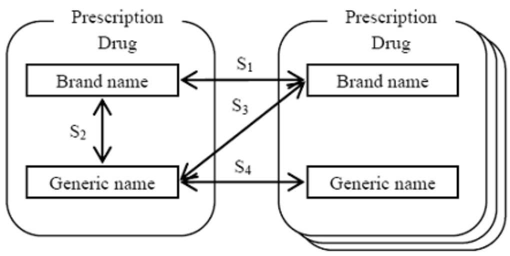

Figure 3: Brand and generic name similarities.

- ***Incorrect Choice based on Brand Name Similarity (S_1)***
  Students tend to select incorrect answers particularly if the choices are similar to each other. With this in mind, we devised a question-based method using name similarity between correct and incorrect answer choices.
- ***Correct Choice based on Brand and Generic Name Similarity (S_2)***
  Some brand names are derived from a generic name. For instance, the brand name, 'CLOZARIL Tablet 25 mg,' is derived from its generic name, 'Clozapine.' With these types of drug names, students had no difficulty associating the brand name with the generic name. In other words, test ques-

tions were easily answered if the prescription drug had its brand name derived from the generic name. Questions based on such similarities were easier for students compared to questions based on other similarities.

- ***Incorrect Choice based on Brand and Generic Name Similarity (S_3)***
  In this study, there were fewer cases where the generic name of a particular drug was similar to the brand name of another drug. With such question types, students tended to select the incorrect brand name. Thus, the more similar a generic name was to the brand name of another drug, the harder the question. In this report, questions based on this type of similarity were effective and provided the next level of complexity for questions exemplified by S_2.
- ***Incorrect Choice based on Generic Name Similarity (S_4)***
  Answers were difficult to identify if the corresponding generic names were similar to the generic name presented in the question. Therefore, students tended to select the wrong answer because the generic name and the generic name they associated with a particular brand name were similar.

2.2 Method for Measuring Name Similarity

Brand names consist of three parts: stem, dosage format, and standard unit. For example, 'Amaryl 1 mg tablet': the stem corresponds to 'Amaryl', '1mg' to the standard unit which expresses the active ingredient content, and 'tablet' denotes the dosage format. Similarity of brand name parts was considered because pharmacists typically use them to identify a prescription drug. In this method, brand name stems were used to measure similarity. To generate brand name stems, standard unit and dosage format was removed according to the method proposed by Kimura et al (M. Kimura, K. Nabeta, F. Tsuchiya, 2010).

In addition, an edit distance algorithm, commonly used to compute character sequence similarities, was employed to measure drug name similarity. Similarity was defined as the number of times required to change characters by insertion and deletion. Values were normalized and subtracted from 1. If the value was equal to one, the string comparison was said to be identical; however, if the value was closer to 0, the string comparison was unrelated.

2.3 Process Generation

The process used to generate questions based on drug name similarity was as follows: 1) instructors input eight parameters that are regarded as maximum and minimum values for each similarity (i.e., S_1, S_2, S_3, and S_4); 2) the computer randomly selects a prescription drug name from a database that best matches a condition, and the drug name is not equal to the generic name and $min_2 < S_2 < max_2$; 3) the computer randomly selects three drugs that best match a condition, and the brand names are not equal to each other and $min_1 < S_1 < max_1$, $min_3 < S_3 < max_3$, and $min_4 < S_4 < max_4$; and 4) the computer generates a question based on the generic name and template input, creates brand name choices, and outputs the question in an HTML file format.

3 EXPERIMENT

Association between question difficulty and name similarity was assessed in order to evaluate the validity of the proposed method. Generated questions were used in an experiment where the ratio between a correct answer and answer time was determined. To evaluate the method properly, an experiment was conducted on 12 students in their twenties who lacked pharmaceutical knowledge and attended the Department of Engineering.

Eight similarity parameters were used in the experiment and three cases were generated as shown in Table 1. In Case 1, brand names in the choices are similar to each other (S_1). In Case 2, the generic name is similar to the brand name of the answer choice (S_2). In Case 3, the generic name is similar to the brand name of an incorrect answer choice (S_3). Similarities corresponding to S_4, which rely on proper knowledge of generic names, were not included in this experiment given the participant's background. Finally, five questions were prepared for each of the three cases presented.

Table 1: Question threshold patterns.

	S_1	S_2	S_3	S_4
Case 1	0.7-1.0	0.0-0.5	0.0-0.5	0.0-0.5
Case 2	0.0-0.5	0.7-1.0	0.0-0.5	0.0-0.5
Case 3	0.0-0.5	0.0-0.5	0.7-1.0	0.0-0.5

During the experimental process, participants were shown a table of generic and brand names and given 150 seconds to familiarize themselves with the content. They were then asked to answer 15 computer-generated questions. Answer time, defined as the response time from question presentation to answer selection, was measured.

4 RESULTS AND DISCUSSION

4.1 Ratios of Correct Answers and Answer Times

Table 2 shows the average ratio of correct answers and average answer times determined for each of the three cases in the experiment. Results indicate that Case 2 had the highest ratio of correct answers with the shortest answer times. As expected, Case 2 represented the easiest question type.

Table 2: Experimental results.

	Average ratio of correct answers (%)	Average answer time (sec)
Case 1	70.0	10.6
Case 2	85.1	7.13
Case 3	58.0	8.72

4.2 Participant Perspectives

A similarity score of 0.83 was obtained between the generic name, ‘Bendazac’, and the brand name stem, ‘Zibensak’. This score corresponded to question nine, which was answered correctly by all participants in the experiment. Moreover, this was the highest score obtained for all questions represented by Case 2. In contrast, question 15, which presented the generic drug ‘Sofalcone’, was missed by 10 participants. In this question, six participants answered ‘Sofarin Tablet 25 mg’, three answered ‘Phardine Tablet 200 mg’, and one answered ‘Falken Tape 20 mg’. The similarity score obtained between the incorrect brand and generic name was 0.73. Participants tended to select choices based on dosage format and standard unit, which were not taken into consideration while computing similarity. In addition, most participants did not select ‘Falken tape 20 mg’, since ‘tape’ is an uncommon dosage format. This result suggests that participants memorized certain brand names by focusing on the dosage format or standard unit of the brand name drug. In a real situation, however, pharmacists do not rely on dosage format and standard unit only, but check brand name as well. Given the importance of associating generic names with brand name stems, the method presented here will facilitate student learning.

5 CONCLUSIONS

In this report, we propose a multiple-choice test which facilitates generic and brand name associations. The test can be implemented as a prototypic learning support system targeting pharmacists. In this study, questions were generated based on prescription drug name similarities. Correct answers were easily identified for questions relating to generic names with similar brand names. However, participants tended to miss the question if answer choices had similar brand names or if the generic name was similar to an incorrect answer choice.

To evaluate the method presented here, we conducted a question-based experiment on students lacking pharmaceutical knowledge, and determined ratios of correct answers and answer times. The highest ratios of correct answers and shortest answer times were obtained for questions having similar generic and brand names. However, in questions with answer choices having similar brand names or where a generic name was similar to an incorrect answer choice, the ratios of correct answers were low and answer times were long. In conclusion, our results suggest that question difficulty can be controlled by focusing on prescription drug name similarities.

Although drug name similarity was the primary focus of the method presented here, additional features regarding semantic drug information (e.g., efficacy) need to be incorporated in order to generate prescription drug name tests. Furthermore, additional methods are yet to be established which focus on contraindication, efficacy, and dosage. Thus, it is important to develop a general method which facilitates adequate prescription drug information and promotes student learning. Finally, effective learning and medical safety must be evaluated.

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