A Case Study of Modeling Technique on Building a Smart Chinese International Learning Environment

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Keywords: Smart Chinese International Learning, Grammar adaptive learning system, Learning analytics technology, Modeling technique.

Abstract. Learning analytics technique is very important to support Smart Learning. This paper applied the concept of Smart Learning based on learning analytics technology. We designed and realized an adaptive learning system for Chinese language learners. This Chinese grammar self-adaptive-adjusting learning system worked by constructing a user data set that recorded the learner’s learning behavior and progress, then used the data to collect on an adaptive mechanism to provide learners with advice, suitable exercises, and related questions based on the user model. This system also presented detailed information about the learner's progress to the user in a visual way. Ultimately, by making design and implementation of Smart Learning environments, the system can create a user-friendly interface for the International Chinese learning system.

Introduction

Smart Learning aims to apply intelligence information technology to the field of education to improve the efficiency of traditional education, and further realize personalized and innovative education. Researchers desire to build a personalized knowledge awareness map system under Smart Learning Environment. It aims at improving the intelligence level of the existing digital education system and achieving the deep integration of information technology and mainstream education (Smart Education, Smart Management, Smart Evaluation, Smart Research and Smart Services). It promotes the development of information technology and sustainable development of education stakeholders (students, teachers, parents, managers, the public, etc.) The process of receiving knowledge and developing better skills is a path that requires certain exercises and a continuously evolving state of equilibrium. The core of Smart Learning is the concept that learning should serve for the better development of the learner's state of mind and abilities [1].

Smart Chinese International Learning Based on Learning Analytics Technology

With the continuous increasing number of Chinese learners, the traditional teaching mode cannot meet the developing needs of Chinese international learning. As language learners come from difference regions all around the world, there are huge individual differences among them. Those differences are mainly reflected in the nationality, mother tongue, age, purpose, learning ability, learning habits and other traits of language learners. The Smart Chinese learning can provide learners with personalized learning support for individual characteristics based on learners' individual differences, learning interests and learning preferences in the learning process. A smart learning environment should have a system that can thoroughly analyze the progress of the learners, predict their future achievements, and discover problems in the learning process which might have otherwise gone unnoticed. Learning analytics technology has already been viewed as the third wave of enormous education development since the creation of the learning management system [2]. It collects and gathers a large number of learning data (including the massive data generated from the
"teaching process", "learning process", "teaching management process"). Through the method of collecting, evaluating, analyzing and recording, the Smart Learning system is able to extract the implied and potential valuable information during the process of "teaching and learning" (or rather "teaching management"). Learning analytics technique provides smart and flexible suggestions for educators' teaching, students' learning, and overall teaching management [3].

This adaptive learning system mainly focuses on the complex sentences part of Chinese grammar. The fundamental part of this adaptive learning system relies on the grammatical knowledge bank of Chinese Complex sentences. Based on the basic information of learners, the results of the previous tests and daily practices, the learning system can analyze and evaluate the student's level of grammatical mastery of complex sentences. And according to their current learning progress, performance and weaknesses in Chinese learning, the adaptive learning system can recommend personalized learning resources and effective exercises. Smart Chinese international learning environment design model as constructed is shown in Figure 1.

![Figure 1. The model of environment design on Smart Chinese International Learning.](image)

This system contains three main modules: data source tier, user model and recommendation engine, application display tier. The data source tier includes a grammar knowledge base covering the English and Chinese explanations and multimedia examples, including a grammar practice test bank with classification of the detailed annotation of the grammar. The user model and recommendation engine module include a personalized user model and an adaptive learning recommendation engine. The learner's personalized model is used to advise and recommend targeted learning resources and exercises to learners through the adaptive recommendation engine. The application display tier includes three parts: the grammar learning, practice and pace of learning. The grammar learning displays the grammar tree and features for learners to learn and participate in class activities. The part of practice is divided into special practice and stochastic practice. Special practice is the exercise for separate and specific types of sentences. Stochastic practice includes the entire grammar learning content. The pace of learning part provides the learners with visualization of the learning progress of the complex sentence type and its secondary grammar point. These three modules aggregate together to build a Chinese language syntax adaptive learning system. In this system, the complex sentence knowledge base is the fundamental core; the user model recommends appropriate learning resources and exercises in order to guide students to study and practice; and students also can see the whole learning progress vividly displayed.

**Data Source Tier**

**Knowledge Base of Chinese Grammar**

Based on differentiation of grammar described in the "Education Guide for Foreign Students' Chinese language learning in colleges (Long Term)", this knowledge Base of Chinese grammar
separates grammar contents into 4 levels by difficulty: Primary Level 1, Primary Level 2, Intermediate Level 3, and Advanced Level 4. There are 12 types of Chinese complex sentence forms; these complex sentence formations include: Coordinate Complex Sentence, Continuous Complex Sentence, Selective Complex Sentence, Cause-Effect Complex Sentence, Transitional Complex Sentence, Hypothesis Complex Sentence, Purposeful Complex Sentence, Progressive Complex Sentence, Conditional Complex Sentence, Concession Complex Sentence, Explanatory Complex Sentence, Contracted Complex Sentence. The database divides the grammar projects according to the complex sentence types and their most commonly used conjunctive words, and collects 90 kinds of different grammatical features that are contained in the 12 complex sentence formations. An example of the connection between complex sentence type and grammar points is as follows (Table 1):

| Complex Sentence Type | Grammar Points |
|-----------------------|----------------|
| Cause-effect Complex Sentence | Because…… (so)…… |
|                        | So             |
|                        | Therefore      |
|                        | Since          |
|                        | For …… reason |
|                        | The reason…… is because of …… |
|                        | ……so as to cause…… |
|                        | So that        |
|                        | Due to ……     |
|                        | Result 1……result 2……, because…… |
|                        | ……, and then…… |

Table 1. An example: complex sentence type and secondary grammar points.

The grammar knowledge base uses many resources to enhance its applicability, such as corpus, textbooks, teaching materials, reference books and so on. The great variety of resources includes but is not limited to internet resources and other Chinese learning databases. It can provide accurate descriptions of the grammar points. The database contains a translation media tool, examples for the grammar points, easily mistaken problems in the usage of the grammar points, and the difficulty in mastering them.

Test Bank of Chinese Grammar

In order to get a better look at how learners are mastering the Chinese grammar and reduce the possibility of recurrence rate of problems, this system provides a gradually increasing difficulty on mastering the grammar points for every complex sentence type. We design a lot of questions to evaluate students’ grammar level and solve their problems. Normally, for the same grammar point we need to prepare a number of different sentences, and the proportion of sentences in different levels of difficulty should be different. In this system, we set 10 or more corresponding questions to each secondary grammar point. As the difficulty level rises, the number of questions will increase. There are in total 1032 questions of various difficulties in this Chinese grammar test bank, that can provide an accurate account of the mastery of all grammar points included in the database.

User Model and Recommendation Engine

There will be three user models that contain the user's information. The first one is the learner's basic identification model which includes information such as learner's name, age, gender, nationality, account password and other features that are not easily changed. The second one is the learner's behavior model, including the time, duration and activities of the learner while studying. This model can offer a deep analysis of the learner's activities and efficiency. It is generated by a series of operations of the time node, such as login time, exit time and learning behavior type. In order to conduct a more in-depth study of learners, the system records learner’s behaviors in the course of the practice, such as the response time, the answer object, the results of the answer and
other data as a basis for learner’s achievement of mastering the usage of these grammar points. The third one is the learner's progress model, which gives a detailed description of the learner's mastery on different sets of grammar points. The system displays the student’s performance in every grammar point and automatically evaluates the student's mastery on the grammar topics during the grammar exercise stage. Based on previous records of the learner's mastery, the system will recommend the appropriate type of questions and exercises of different categories and difficulties. After reviewing the learner's activities of the grammar point, the progress model is adjusted. The system will change the progress model based on the grades received. If the grammar point is only partly mastered or not mastered at all, the system will take note and change the progress model, planning future approaches to this particular grammar point. So this is an adaptive learning system.

**Application Display Tier**

The application display tier is separated into three different modules: grammar learning module, grammar practice module, and progress overview module. The user of this tier can enter a selection list of the complex sentence types (Figure 2). Students are free to select the content they want to learn and view; they can learn the content of the grammar point (Figure 3). The learner's grammar learning is personalized by the system. The system decides for learner whether he or she should learn simply grammar points or complex sentence types. Different indexes are created for different choices, and the resources collected in the database will be provided accordingly. It is a big project to make grammar point annotations of every complex sentence type. We need to note them with English and Chinese explanation, pragmatic examples, pictures and video resources. Based on the degree of mastery of the current learner (the overall degree of mastery = Σ (the degree of complex sentence type) / the number of complex sentence types), the grammar learning module will select a certain stage of the minimum degree of secondary grammar points and recommend to the learner. The Grammar learning module will select special grammar topics based on the previous mastery and progress of the learner, and suggest the least-mastered grammar topics for the learner to improve more effectively. For those whose overall progress in the subject is less than 30%, the advising system will only recommend and select primary, easy level grammar points for the learner. For those whose overall progress is between 50% to 70%, intermediate level grammar points will be taken into consideration for the advising system. When the learner reaches the final stage, with a 70% overall mastery or better, all grammar points of various difficulties and level of mastery will be considered by the advising system. The advising system will dig deep into the information collected from the previously mentioned learner statistic model, conduct a comprehensive analysis of the information, and give suggestions to learners that can best help them crack the difficult grammar points and fix the hidden problems in the learner's grammar usage.

![Figure 2. Selection of complex sentence types.](image-url)
The grammar practice module offers different types of services. It offers suggestions to learners, helping them master the grammar points and complex sentence types where they showed least satisfactory performance, increasing the times the learner needs to practice these grammar points. It can also provide specific training for learners on a particular recommended topic, or allow the learners to choose for themselves what to learn and practice. For those who are not sure where to work on, the grammar practice module can also help them by giving them quizzes selected randomly from the resources database. After the user turns in their answers, the system will automatically grade the questions and give accurate feedback on the learner's level of mastery in all grammar points based on the difficulty of questions, category of topics, and accuracy of answers.

The studying progress review module uses graphs to give the user a clear picture of one's progress. It displays the pace of learning in a graphical way, which provides a more intuitive presentation for the learners. It is a visualization module. The degree of mastery for complex sentence types will be shown as a bar-graph, while the progress in a detailed grammar point will be indicated by the different depth of color. An example of the pace of learning in progress review module is shown in Figure 4.

**Summary**

Smart Learning is a new method of education built upon developments in information technology. It includes providing Smart Learning environment, smart management, and smart resource database. It is a revolutionary change from traditional education methods [4]. This research has now
completed the self-adapting education system concerning complex sentence types. It will continue to construct all other self-adapting systems for International Chinese language learning, hoping to achieve effective construction of a complete learning environment for Smart Chinese Learning. With the help of the Learning analytics technology, teachers have more opportunity to discover the real learning situation of each student. The Smart Learning environment can help students to assess their academic progress, predict their future performance, discover their potential problems and get suggestions. Therefore, Smart Learning can provide high-quality, personalized educational services to every student and raise intelligent, well educated people.

Acknowledgements

This paper is supported by 2015 Humanities and Social Sciences Fund Project of Chinese Ministry of Education (NO. 15YJAZH089). The project title is Empirical research of learning analytics in flipped classroom of teaching Chinese to speakers of other languages.

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