Can The Adaptive Inquiry-Based Learning Teaching Model Work Effectively? An Experimental Study

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Abstract. In this paper, an experiment was performed on the student who learned in an adaptive inquiry-based learning (AIBL) teaching model. The authors examine whether we can better encourage students to learn in AIBL teaching mode. It suggested that undergraduate freshmen in the AIBL teaching mode can get scores as good as those in the traditional collective classroom (CC) teaching mode, but they can’t adapt to the inquiry-based learning individually.

Introduction

Hundreds of MOOC courses, which students must watch a designated video and participate in a certain amount of discussions and communications within a course term, come out too low finishing rates because of its traditional teaching mode, which completely ignore the individual characteristics of students. Adaptive learning technology is a way to provide flexible opportunities for personalized learning [1], of which main purpose is to improve the learners' learning effectiveness[2].

Adaptive learning is also called intelligent learning. It is a technique that supports learners to adjust their settings to suit for their personal learning need, and it is the ability to automatically adjust learning content and learning patterns according to learners' personality learning style, cognitive preference, cognitive style, knowledge background and ability. We can use semantic web technology based on ontology construction, learning resource meta data specification, domain model, semantic association and retrieval[3,4], user behavior analysis technology based on data mining[5,6] to dynamically construct learning resources and content based on fuzzy logic and genetic algorithm[7,8], ability measurement of subjects based on item response theory[9], learning style test model[10], and recommendation model based on collaborative filtering[11]. Learning style model and intelligent adaptation of learning situation are the key technologies in adaptive learning systems.

However, adaptive learning is not only for mobile learning. It is also possible to adopt an adaptive individualized learning teaching mode, namely "small class learning", in the traditional small classroom teaching. If there is a lack of effective instructional design, the teaching mode, in which the CC teaching mode is along with the time and space elements, becomes the most authentic independent learning - self-studying. Whoever can insist on self-studying should have strong curiosity about what they are learning, and has a strong self-control, but only a few Chinese students are willing to learn and capable of self-control according to the authors’ own observation and study. To solve the problem, we find the inquiry-based learning (IBL) teaching mode fortunately.

IBL teaching mode is helpful to stimulate students' enthusiasm in study to train innovative spirit in students and to improve students' thinking and ability of cooperation consciousness. In IBL teaching mode, students become the masters of learning and teachers play the role of guidance[12,13], in which students are leaded to explore in many experiments and activities. Therefore answers or results of research projects are often uncertain [14]. The China central education authorities issued a document more than 10 years ago for developing the IBL teaching models in primary schools, whose models under network environment also become the focus of the
current higher education [15,16,17]. IBL teaching mode is also regarded as the first step to improve college students’ Information Literacy [18].

According to the constructivism conception of learning and teaching, which is basis of the IBL, knowledge is described as declarative knowledge and procedural knowledge [19]. But there is a lack of studies on adaptive IBL teaching mode. Adaptive learning means that students can omit those knowledge and skills that they have learned or known, and can autonomously choose things below: learning materials according to the needs of the research project, their own time and places to study, subjects to research. This paper will provide an empirical study of adaptive teaching mode from the perspective of AIBL with assistance of computer systems.

**Objectives and Hypotheses**

**Objectives**

By experience, we can get information about students’ ability of adoption to the AIBL teaching mode and pattern of students aided by learning assistant systems (LAS). It will be helpful to generalize the AIBL teaching mode, and provide references for further research. Moreover, it will provide useful information for further research.

**Hypotheses**

Hypothesis 1: In our AIBL teaching model, most students will be as good as students who are in our CC teaching model.

Hypothesis 2: Students will know the knowledge points from adaptive LAS, and pass the quiz until he/she knows all knowledge of these points autonomously.

Hypothesis 3: Students can learn the inquiry-based learning mode autonomously, and can choose some topics by themselves for research.

**Methodology and Results**

In order to examine how students learn knowledge and skills when they follow an AIBL teaching model, we performed an experiment on them. There were two main parts. In the first part, terminal exam scores were examined. In the second part, the students’ using styles in certain learning assistant computer systems designed for AIBL, and their experiences of inquiry-based learning were explored. Analysis were carried out for point of declarative and procedural knowledge respectively in the above two parts by SPSS ver20.

**Learning Assistance and Test Systems**

We have four systems to support students learning bibliography retrieval knowledge and skills, aiming to help students review or check levels. Each of them can be used for any course without change system codes and be based on the formal three-tier C/S mode structure which consists of three layers. Students’ quiz is in interaction layer; interface displacement is controlled by data views. Data store layer will store any data created or imported by system users such as test questions, answers of test questions and information of students. Table 1 shows differences of four LAS.

<table>
<thead>
<tr>
<th>System Version</th>
<th>Interactive With Teacher In System</th>
<th>Times Of Repetitions</th>
<th>Number Of Unit Quiz</th>
<th>Test Duration Settable</th>
<th>Question Duration Settable</th>
<th>Testing Sort Of Quiz</th>
<th>Limitation Of Logging</th>
</tr>
</thead>
<tbody>
<tr>
<td>U ver1.0</td>
<td>no</td>
<td>0~3</td>
<td>limitless</td>
<td>yes</td>
<td>no</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>TES</td>
<td>no</td>
<td>0</td>
<td>-</td>
<td>yes</td>
<td>yes</td>
<td>-</td>
<td>yes</td>
</tr>
<tr>
<td>STES</td>
<td>no</td>
<td>limitless</td>
<td>-</td>
<td>0</td>
<td>yes</td>
<td>-</td>
<td>no</td>
</tr>
<tr>
<td>U ver2.0</td>
<td>yes</td>
<td>limitless</td>
<td>limitless</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>no</td>
</tr>
</tbody>
</table>
The TES has been designed for terminal exams, and STES is a simulation system of TES. Students can use TES only one time, but STES can used many times. Students can log in the STES anywhere at anytime, but should log in the TES system only in certain computer room in certain time under the supervision of teachers. Students can log in the two UQS systems anywhere at anytime according to their teachers’ definitions. The two UQS systems have been designed for students with different object: ver1.0 is used by students after every classroom teaching time to help themselves with reviewing; ver2.0 is an adaptive LAS, which is designed for AIBL teaching mode and be used by students to help themselves to know points of knowledge or skills about the course, and to check their own levels of these points.

There are four other differences between ver1.0 and ver2.0. First, each unit quiz in both ver1.0 and ver2.0 is created individually by teachers according to knowledge or skill points of TES. Second, the duration and repetition checking of each quiz in ver1.0 can be set on or off individually. If repetition checking of unit quiz in ver1.0 is on, the quiz can be repeated only 4 times, but the repeated times in ver2.0 is infinite. Third, a student can test any other unit quizzes in ver1.0, in which all questions will be answered even if one gave correct answer before. Unlike UQS ver1.0, each question in UQS ver2.0 should be test many times until it is answered correctly, a student can’t begin the second unit quiz unless he/she has got a 100 score in the first unit quiz. Fourth, the duration of each test question in the UQS ver2.0 is equal to the duration of same knowledge points defined in the TES, but there is no duration for each test question in the UQS ver1.0.

In this paper, the website of the Bibliography Retrieval course and the Tencent QQ group tools are also used to support learning, the four LAS along with videos and other types of reference documents can be download from the website. Students can also buy the recommended textbooks of the course.

**Experiment Design**

**Model of AIBL and CC Teaching Mode.** The AIBL teaching model we used in this experiment consists of four modules: classroom module, online module, offline module and team module. In classroom module, teachers introduce the meaning of AIBL teaching mode and the learning schedule of this course to the students, and share with students about their research experiences. In online module, teachers inform each student of the learning progression of each students and discuss knowledge or research projects with students. In offline module, students learn knowledge autonomously with the assistant of the UQS ver2.0 and material he/she can get access, then put question through the UQS ver2.0, QQ or email systems and read the answers from teachers. In team module, students discuss their research project defined with the team members cooperatively, and finish the design drawings or reports of projects. In general there are two kinds of error paths. One is learning without study(ER I) and the other is researching without learning(ER II).

The CC teaching model we used in this experience consists of two modules: lecture module and review module. In lecture module, teachers introduce knowledge or demonstrate skills to students. In review module, students review knowledge or skills with assistance of UQS ver1.0.

**Samples’ Description.** There are 198 undergraduate freshmen from school of information (as shown in Table 2), the teacher 2 taught 85 students from course class 2 in AIBL mode, and the teacher 1 taught the others from course classes 1 and 3 in CC mode.

<table>
<thead>
<tr>
<th>Course Class No.</th>
<th>Learning Mode</th>
<th>Course Teacher No.</th>
<th>Attending Students Number</th>
<th>Number of Grade Classes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>CC</td>
<td>1</td>
<td>58</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>AIBL</td>
<td>2</td>
<td>85</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>CC</td>
<td>1</td>
<td>59</td>
<td>2</td>
</tr>
</tbody>
</table>

Test questions samples come from the LAS and TES systems. There are eleven unit quizzes containing thirty-five questions about thirty-five points of declarative knowledge and twenty-seven
questions about twenty-seven points of procedural knowledge in the UQS ver2.0 for students in course class 2, and five unit quizzes containing 139 test questions about same knowledge points for students in course class 1 and 3. All students can use UQS ver2.0 or STES to test questions in STES. There are also twenty-seven questions about twenty-seven points of declarative knowledge and three questions about three points of procedural knowledge were extracted randomly from library of terminal exam test questions according to system rules defined by all teachers cooperatively in TES for all students.

**Design and Procedure.** The experiment was taken in a course term which was during Feb 24, 2017 and Apr 8, 2017. Students in the AIBL model should have finished certain quizzes before each Thursday from the first to the fifth week according to combination of quiz as following. Quiz 1 and quiz 2 for the first week, quiz 3 to quiz 5 for the second week, quiz 6 to quiz 8 for the third week, quiz 9 and quiz 10 for the fourth week, quiz 11 and quiz 12 for the fifth week. Each student should autonomously belong to a team which include other members and a leader only. Each team submit the report or document before the eighth Thursday.

Table 3. Experience Defined Two Type Samples.

<table>
<thead>
<tr>
<th>Course Class No.</th>
<th>Number of teams</th>
<th>Course Time(Thursday)</th>
<th>Course Schedule</th>
<th>Classroom Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>13:00-15:05</td>
<td>1 week 1 quiz</td>
<td>7 weeks</td>
</tr>
<tr>
<td>2</td>
<td>12</td>
<td>15:25-17:00</td>
<td>1week 2 or 3 quizzes, 1 report before the 7th week</td>
<td>the 1st, 6th, 7th week</td>
</tr>
<tr>
<td>3</td>
<td>0</td>
<td>15:25-17:00</td>
<td>1 week 1 quiz</td>
<td>7 weeks</td>
</tr>
</tbody>
</table>

**Data, Variables and Coding Rules.** At the end of the course term, there were 2 and 1 students be absent in terminal examination.

Students created data while using the TES and UQS, such as scores of terminal exam according to knowledge point, total seconds they spent in each question of the terminal exam or the UQS and quiz repetition times they done in UQS. These variables can be analyzed directly, also can be used to generate other data for further implications. For example, we can calculate the timeliness and system dependence of students to find that if a student has finished the quiz in time according to the time points of answering and the schedule of the course, and can find that if a student usually used the UQS ver2.0 in course time.

**Hypotheses Testing**

There are 14(24.1% of 58), 20(23.5% or 85) and 2(3.4% of 59) informal students in course class 1,2 and 3 respectively. Obviously, both our CC model and AIBL model are not suitable for them. These student samples were included in Hypothesis 1 test for the purpose of revealing experience of most formal students.

Hypothesis1 is about effectiveness of our AIBL teaching model. Independent t-test demonstrated that there is no significant difference between average scores of formal students in course class 1 and 2, but the average score of formal student in course class 3 is more than that of students in course class 2 (1.35 declarative questions and 1.43 procedural questions, P<0.05). However, we can’t say that the Hypothesis1 is not true, because the average score of formal students in course class 2 is nearly equal to that of formal students in course class 1 and 3.

Hypothesis2 is about students’ understanding of the UQS2.0, if a student wants only to learn knowledge by passing quizzes, he/she will use the UQS frequently. At the first two course weeks, a few students couldn’t finish the first 5 quizzes in time. We knew the reason from interview that some students were unwillingness to reference any other materials about the quiz, and couldn’t pass the first quiz by repeating many times. On the other hand, 85 students in course class 2 have tested 503 declarative knowledge unit quizzes and 419 procedural knowledge unit quizzes, the ratio of units being repeated in 300s is 72.8% and 64.1% respectively. Hypothesis 2 is fully supported because of the two high ratios.
Hypothesis 3 is about the effectiveness of inquiry-based learning in our AIBL teaching model. But from our observations we found that almost all of the teams in course class 2 consulted about the research projects until the fourth week. Many teams submitted patent ability reports with errors or patent specification documents with copied paragraphs of some patent specification documents downloaded from databases. Surely, Hypothesis 3 is not supported.

Discussion and Future Research

This study offers a number of implications for teaching practice according to the hypotheses test and evidences of this experiment as following:

First, although it is notable that scores of formal students in AIBL mode are not significantly better than that of formal students in CC mode, the advantage of AIBL is obvious considering the number of test questions for students in course class 1 and 3, which is much more than that for students in course class 2. Unlike the students in MOOC or CC teaching mode, the students in AIBL teaching mode will not be forced to watch video through internet or watch teacher’s lectures in classroom and will have research experience during the course. Teachers in AIBL mode needn’t to monitor or control the student in classroom too.

Second, it is obvious that we must not act on assumptions, especially for AIBL mode, the prior investigation and guidance about the inquiry-based learning teaching mode should have been done.

Third, it is not strange that most students involved in the AIBL mode tend to repeat quizzing frequently according to constructivism conception of learning and teaching, students are favorite to learn in practice. We can take advantage of defining all knowledge points into the UQS on one hand, and create more learning material that is easy to understand and very lively.

Although this study makes several contributions, it has also limitations that provide opportunities for future research as following:

First, student samples come only from freshmen in school of information, girls are few. But effectiveness of our AIBL teaching model may be different between students in different grades, schools, genders, and so on.

Second, learning experience survey reports of student were not involved in samples about learning effectiveness.

Third, the individual characteristics of students who got the low scores should be considered in AIBL mode.

Conclusion

Motivated by our own experience in teaching, this study focuses on exploring how we can better encourage students to learn in AIBL teaching mode and what is the most ideal model. Drawing on the constructivism conception of learning and teaching theory, we realize that the CC teaching mode can be transformed to the AIBL teaching mode, which would lead to students' different learning experiences. Through the conduction of this work, the results offer some guidelines to teachers on teaching in AIBL mode. I call for future research to explore more towards this direction.

Acknowledgement

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References


