A personalised digital classroom with improved interactive responses

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ABSTRACT: An interactive response system (IRS) has been developed for multimedia classrooms, in which a master controller connected to the teacher's computer enables interactive responses received from students` terminals to be projected on to a screen. To meet the personal learning demands of students, further improvements to IRS - referred to as IRS+ and IRS++ - are built into the personalised digital classroom, developed by the Smart Education Experimental Base of Wenzhou Vocational and Technical College. This work provides a reference for the construction of smart classrooms.

INTRODUCTION

At present, school teaching is mainly the classroom teaching of classes. From past times to present, the traditional classroom has one teacher teaching many students. This is easy to organise, but has disadvantages. Because, there is one teacher to many students in the traditional classroom, it is generally recognised that the students should have understood the contents of the lesson when the teacher finishes teaching or that all the students should have understood the contents, if several have. Students falling behind in class can study by themselves or ask the teacher after class. If students with weaker ability or who are inattentive in class do not spend additional time in prompt compensation, the problems from each classroom session will accumulate. This certainly will drive such students to become poor students. On the other hand, students with strong ability may waste time waiting for slower classmates and become distracted in class. In the traditional classroom, the teacher can only learn the state of students' learning through questions or sample tests and so much time is taken up in correcting and recording homework.

Many teachers from the front line of teaching have long noticed the differences between student personalities, and recognise that students are the subjects in the learning activities. Even though they make their best efforts to improve their teaching, it is difficult for the single teacher to teach students in accordance with their individual responses in the traditional classroom. To meet the personal learning demands of students, classroom teaching reform is ongoing, from improving the teacher's teaching to the students` learning from home, resulting in the following research on practice in teaching, viz. problem-based learning, collaborative learning, practical learning, autonomic learning and active learning, among others. Each is supported by a corresponding learning environment [1-6]. Combining the relevant technologies of digital learning, the author studied the personalised digital classroom with a one-to-one digital interaction.

DIGITAL LEARNING TECHNOLOGIES

Interactive Response System (IRS)

As shown in Figure 1, the interactive response system (IRS) consists of the students' terminals (or wireless handheld voters or remote controls), and a wireless transmitting and receiving master controller connected to the teacher's computer, all with one set of interactive response software [7]. The system is available in the multimedia classroom, in which the master controller connects the teacher's computer, displaying onscreen the interactive responses received from the students' terminals. The teacher can test students using pre-set true/false or multiple choice questions. The students' results immediately can be summarised and displayed on the screen. The display can identify students who have not answered, and students who have answered early or late. Finally, the teacher publishes the standard answers and comments for correcting wrong answers.

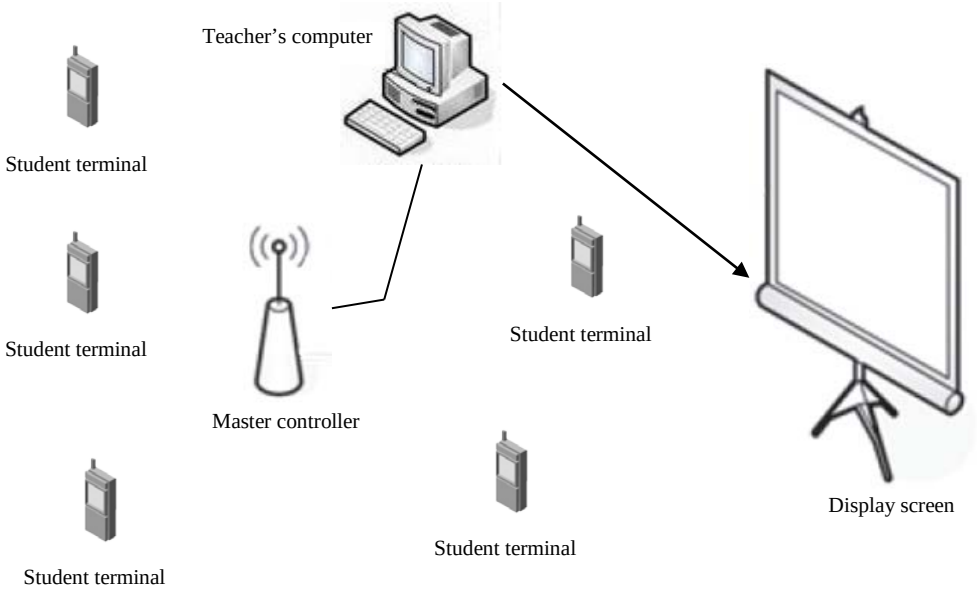

Figure 1: The interactive response system.

Electronic Schoolbag

Electronic schoolbag refers to a PAD (personal application device) with digital learning resources and learning management software [8]. This can be used to search and acquire authorised learning resources from a server on a wireless network. Its purpose is to facilitate classroom interaction, homework, examinations and learning exchanges. Through an electronic schoolbag, the students can view the learning plan, preview and learn independently before the class, as well as receive the teacher`s shared learning materials.

Using the electronic schoolbag, students can interact and participate in dynamic learning, investigative learning, group collaborative learning, reflective learning, practical learning and independent learning in the class. After class, they can review, do homework and take after-class tests. As organised by the teacher, the students can realise personalised learning through the electronic schoolbag. The slight disadvantage is that generally students' own smart phone, PAD and other equipment are not allowed to be used freely as the electronic schoolbag.

One-to-One Digital Learning

One-to-one digital learning has been developed to resolve the disadvantages of the one-teacher-to-many students teaching [9]. In recent years, there have been many studies and improvements in this field; for example, based on the *pedagogy wheel* of Allan Carrington. Jiao et al proposed a PAD-based one-to-one teaching model for digital learning by integrating activity theory, a mobile learning system and blended learning theory [10].

The structure of a one-to-one digital learning system includes equipment with various learning resources and learning software for each teacher and student. After accessing the wireless network, a student can start personalised learning. They can participate in interactive responses, appraisals and other learning activities.

The essential meaning of *one-to-one* is that, with the organisation and guidance of the teacher, one piece of digital learning equipment is provided for each student, and it also deals with that student's personalised learning. Each student can start personalised learning in accordance with their own independent learning needs. In the class, the teacher can ask students to answer questions, arrange group discussions, receive and dispatch assignments, set examinations, and so on.

Cloud Desktop

The desktop realised through cloud computing, dynamically distributes the software and hardware resources and is a kind of virtual computer, which has the same functions as the daily use PC computer [11]. The virtual computer has effective performance due to the speed and storage space on the server. Batch management of the virtual computer is convenient; virtual computers can be created or deleted quickly; and the operating system of the virtual computer can be replaced quickly on the server. Users can log-in to the virtual computer using a smartphone, PAD, laptop or PC.

The virtual computer has the same interface or desktop as a normal computer, and so it is called a virtual desktop or a cloud desktop. In the digital classroom, a smart phone, PAD or even an old PC can be a student's terminal. With cloud desktops the hardware resources are on the server and so its hardware performance can be very high, with powerful functions and convenient management and maintenance.

Knowledge Database and Big Data Analysis

Big data provides a new way to analyse and resolve learning problems in the digital environment. In the digital classroom, mass data can be automatically collected across multiple dimensions of performance and the environment of both teachers and students. These data can be integrated and used to construct a knowledge base for statistical analysis and data mining, to assist teachers and students to adjust the teaching and learning in a timely and effective manner. Big data-based learning analysis can describe the learning and the learning state of each student, in detail, at every stage of the learning, to form the basis of improving the teaching by teachers and the learning by students [12].

Remote Classroom and Virtual Classroom

In traditional classroom teaching, problems arise if a student cannot attend a class or if a teacher is unable to give a class. These traditional classroom problems can be resolved through the remote classroom or virtual classroom in the digital learning environment:

- The remote asynchronous classroom:

  The teacher can record a lesson by video and make it available on the Internet for the students to download. They watch the classroom video and, then, can do homework or a test as required. This format is used for many current on-line teaching courses, including most MOOCs (massive open on-line courses). The main feature of this method is that instead of a specified time for learning, the students may learn at a time to suit their practical situation. Also, the teacher can record the teaching at a time that suits the teacher. The disadvantage is that the real time interaction between the teacher and students is missing, and so such exchanges would have to be performed through some appropriate communication exchange platform.

- The remote synchronous classroom:

  Remote video conferencing technology can be used to set up a remote synchronous classroom, in which the teacher and students are remote from each other but interact in real time. It is even possible with virtual immersion technology to create a vivid experience using telepresence. Thus, the synchronous classroom supports the prompt interaction of the classroom, but without requiring a physical presence in the classroom.

- The virtual classroom:

  Users can experience learning in the virtual classroom through being replaced by virtual users. In their virtual roles the teacher and students can realise the real time interactive response in the virtual classroom through human computer interaction [13].

PERSONALISED DIGITAL CLASSROOM WITH IRS++

The Interactive Response System

The digital learning engineering development team of Lingnan Normal University designed a response system, with multifunctional wireless voting and scoring with IRS (interactive response system) functionality, referred to as IRS+ [14]. It supports Bluetooth, Wi-Fi and other types of communication. A student's terminal can be a simple terminal with the traditional cell phone appearance, a smart terminal similar to a PAD or a terminal realised by installing the software onto the cell phone, PAD or other smart electronic device. Additional terminals may be a student's smart phone, PAD, laptop or PC. The disadvantage of the additional terminal might be time differences due to the different speeds of the communication protocols. Fundamental data, including students' information, interactive response questions, and so on can be stored on the local hard disk, with the remote server handling the management of the local software interface or remote website interface. Results and statistical information may be exported to Excel or Word documents.

With the system consisting of master controller, teacher's computer and students` terminal, IRS+ has the main functions of the electronic schoolbag and be used in the classroom as a one-to-one digital learning environment. The students can use the teacher's learning resources shared on the server at their convenience for independent learning, group collaborative learning, investigative learning, class interactive responses, and other learning activities under the organisation and guidance of the teacher. The main functions of the matched management platform software include data management, attendance tracking, responding, voting, scoring, interactive response, electronic hand-up function, *kickout match* and statistical analysis.

Improvement to IRS

With the support of the Smart Education Experimental Base in Wenzhou Vocational and Technical College and the fund support from Zhejiang province, a further improvement to IRS+, dubbed IRS++ is described in this article. This involves building a personalised digital classroom, to enhance the performance and functions of the students'

terminal. The server for IRS++ is upgraded to have a cloud architecture providing a cloud desktop for the student's terminal, with the same performance and functions as a PC. The following are added to the management software: teaching administrative platform, independent learning platform, questionnaire platform, and test and examination platform. The teaching administrative platform supports the following administrative and teaching areas: departments, classes, discipline, courses, enrolment, teachers` information, semester plans, course planning, curriculum schedule and performance.

The independent learning platform is one type of personal learning environment available for various learning activities and self-examination, in or out of class. The student terminal can acquire all the data for the teaching and the state of learning. This latter can be stored in the knowledge base for big data learning analysis, to provide assistance for students' learning and teacher's teaching. This analysis is used to identify teaching problems, learning behaviour, learning capacity, and the learning routines of excellent and poor students. The analysis uses cluster, outlier, decision tree and other algorithms.

Semantic analytical reasoning using heuristics can lead to recommendations about personalised learning programmes and learning resources. Even the automatic scoring of subjective essay-style questions can be realised by using a fuzzy reorganisation algorithm. Using the cross-score function of the test and examination platform, complicated subjective questions can be set in the classroom. The process related to complicated subjective questions is shown in Figure 2. A description of the steps follows.

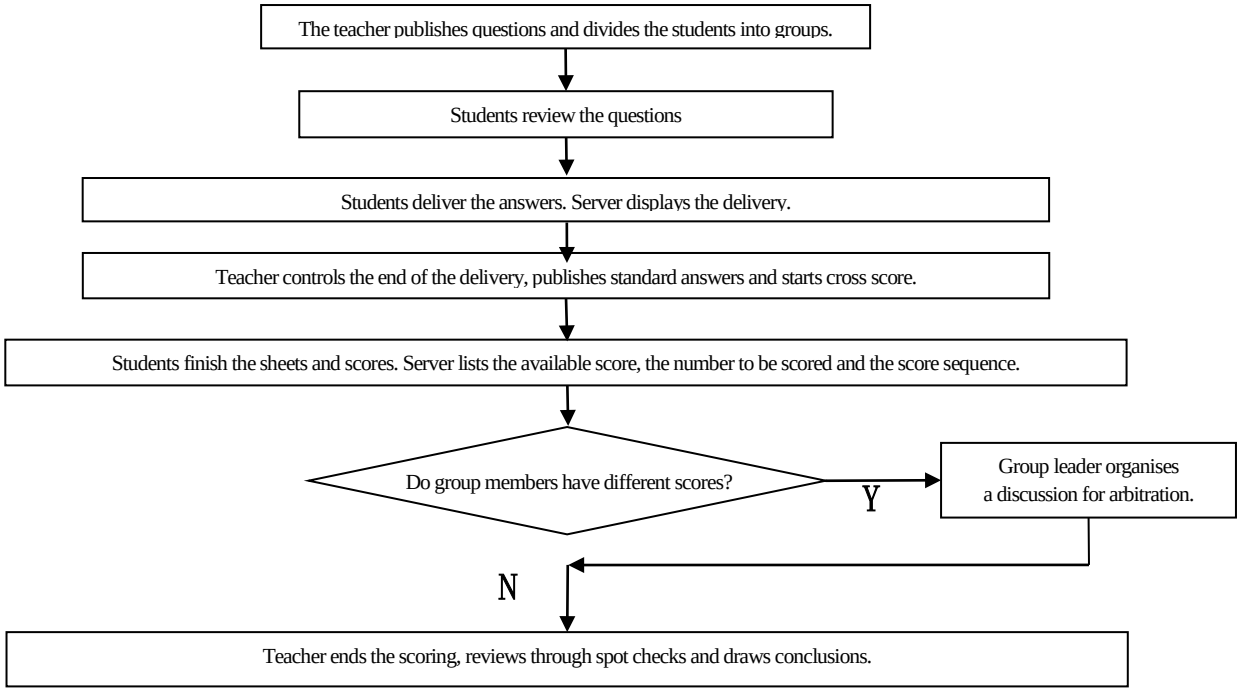

Figure 2: Score flow chart for complicated subjective questions.

- Step 1

  The teacher publishes questions and automatically or manually divides the students into groups.

- Step 2

  The students view the questions on the screen or downloads them on to their terminals.

- Step 3

  The students answer the questions. For experimental and practical questions, the terminal screen shot or picture or operating results document is inserted into a video. Mathematical calculations can be delivered as a picture by using drawing software or a photo of the terminal. The answer delivery information of every student is listed on the screen. Information includes when and who has delivered, who has successfully delivered, and who has failed. The teacher decides whether to allow delivery by photo. Although taking photos is troublesome, it has some advantages, including that of data archiving.

- Step 4

  The teacher ends the receipt of answers, publishes the answers and scores, and starts the student groups cross scoring.

- Step 5

  The students download the answer sheets for cross scoring, during which the students can ask the teacher for assistance. On the screen, the scored and unscored parts for each group are listed. For each student, the average score of the finished parts and that which has not been finished are displayed. The scores are ranked from high to low. Each group has a group leader. When there are different scores from two or more members, the leader organises a discussion for arbitration and an arbitrated score is decided upon. In such circumstance, the arbitrated score is the final score.

- Step 6

  The teachers control the stop of the score. One or two groups are reviewed through spot check, and this interactive response is finally concluded. All the data records are stored on the server for generating the learning evaluation. The teacher and students can search the statistical analysis results within their accesses.

Personalised Digital Classroom

The personalised digital classroom has one camera at the front and one at the back of the classroom. If possible, a camera with console control and microphone will be used for recording and broadcasting the classroom learning in real time for remote or virtual classrooms. The personalised digital classroom provides a one-to-one digital interactive response. The overall physical structure is shown in Figure 3.

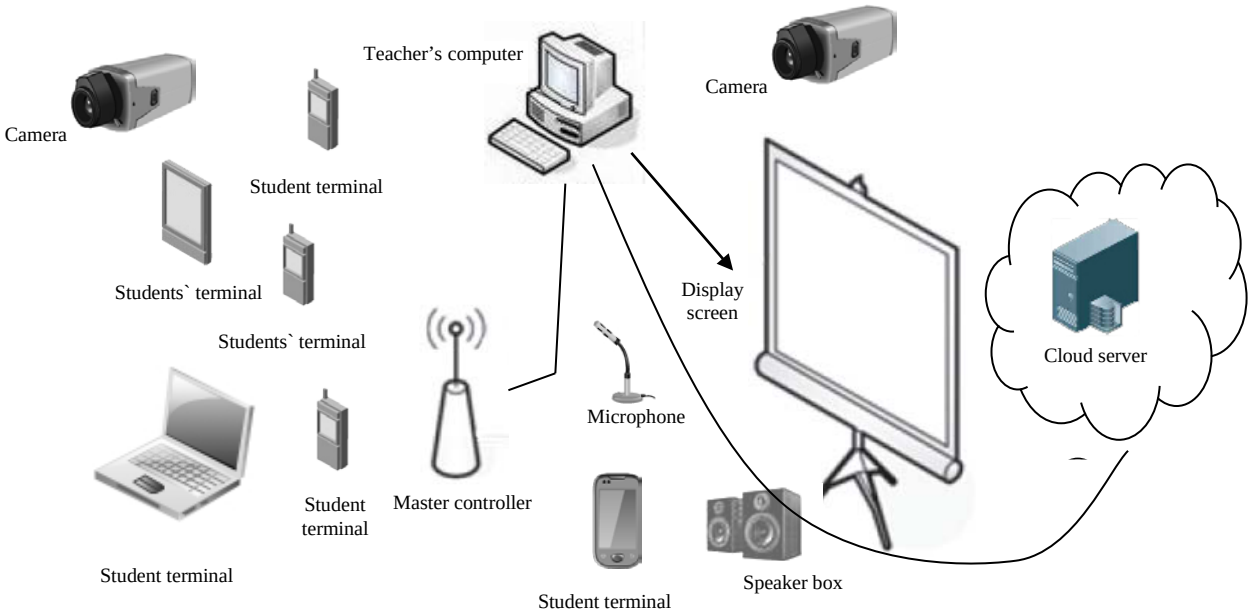

Figure 3: Physical structure of the personalised digital classroom.

IMPACT OF IRS++ ON TEACHING

Smart phones, PADs and other terminal devices can hold massive amounts of teaching software. The application of such smart devices in teaching creates a new teaching model, which has been studied by scholars in China and abroad. The personalised digital classroom with one-to-one digital interactive responses established by IRS++ is a highly functional smart terminal device. This allows students to develop the learning and studying habits to immediately search resources to answer questions, and to undertake investigations by themselves and, at the same time, to exchange and share information and experiences with others.

The impact of such a learning environment on learning is to influence and improve students' thirst for knowledge and to stimulate interactions among students, by providing the students with the tools and information resources they require. In addition, the personalised digital classroom allows the teacher to accurately and finely control the teaching process and supports the teaching administration.

The personalised digital classroom does not treat classmates as all being at the same level. Students learn what they can learn and reach the standards they are able to attain. The aim is to prevent normal students from falling behind due to insufficient participation in the classroom, while still providing the more competent students the expanded learning resources for their further improvement. No matter how strong the learning environment, it comes into play only under the right organisation by the teacher. The upgrading of the learning environment requires that the teaching model of the teacher be improved accordingly. The teacher's information can be improved continuously in using the IRS++ tools and resources.

CONCLUSIONS

Based on an improved interactive response system, the personalised digital classroom is one type of future classroom learning environment. Regarding the students' learning as at the centre, this work outlined the realisation of an interactive response classroom, permitting remote students or students using virtual avatars to participate in real time classroom interactions. Students are taught in accordance with their aptitudes; thus, improving overall teaching efficiency.

At present, the personalised digital classroom reported in this study is under construction and small scale testing in the laboratory of Wenzhou Vocational and Technical College has been undertaken. The application of this environment is going to be part of an empirical study in the next step of its development. The personalised digital classroom will be continuously optimised, and should provide a reference for study in the relevant fields.

ACKNOWLEDGEMENTS

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