Abstract—This study applies cloud computing combining the theory of learning hierarchy to the digital learning assessment and remedial instruction, and explores the learning effectiveness on the learning model of self-learning in Chinese idioms. In this study, 60 students in grades three to six of an Elementary School in Nantou County of Taiwan participated in the research experiments. The results of this study reveal that the learning on Chinese idioms through the cloud-based E-learning assessment and remedial tutoring system is superior to the traditional reading to learn. The learning achievements of the students learning Chinese idioms by the proposed system are significantly improved. Therefore, the cloud-based E-learning teaching materials, methods of assessment, and remedial instruction are worth to develop and research.

Index Terms—Cloud computing, E-learning, hierarchy of learning, learning assessment, remedial tutoring.

1. Introduction

The development of E-learning has been accompanied by the evolution and development of Internet. The primary feature of E-learning is allowing the learners to learn anytime, anywhere in the student-centered learning environment, therefore, the learners can freely and independently implement learning. In the past, before building the E-learning system, a web server and database have to be constructed, plus the functionality and security enhancement, it will increase the costs of manpower and time[1]. Due to the advancement of cloud computing technology, coupled with some of the market leading IT service, providers vigorously promote cloud services and provide powerful cloud computing capabilities and application service environment, the problems mentioned above no longer exist. In addition, people have Internet access anytime, anywhere to browse the web or do their works[2]. The portable mobile devices are improved from traditional large volume devices into thin and light mobile smart devices, so that the people can travel with lighter and more convenient devices to retrieve information.

Idioms play a very important role in Chinese learning, because the use of the idioms helps the high-level language cognitive learning and applications. Moreover, it can foster the learners’ understanding of the rhetoric in writing, and enhance language capabilities and skills. Therefore, idiom learning is an important basic training no matter in reading or writing. It can make the expression briefer and more precise. The usage of idioms can improve the quality of the expressions, and strengthen the effectiveness of speaking. Therefore, this study applies cloud computing technology combining the theory of learning hierarchy to construct a cloud-based E-learning assessment and remedial tutoring platform on Chinese idioms learning. In the future, the users of the E-learning systems only need a device equipped with a browser and Internet connection, and they will be able to complete the general required work. Thus, the users on the cloud-based E-learning assessment and remedial tutoring platform do not need to worry about the operating system, software and hardware, which will be solved by the cloud computing services, and the users just simply concentrate on the course instruction and learning.

2. Literature Review

2.1 Cloud Computing

Cloud computing is not a technology, but a concept. It is a network exchange pattern based on the use of computer technology. Cloud refers to the Internet, cloud computing is to use the Internet to communicate with more than one computer’s computing tasks or to obtain the services provided by the remote host over a network connection. The cloud computing technology was first proposed by the Amazon for the online shopping platform, and later on Google and Microsoft followed[3][4].

Cloud computing is one kind of shared IT infrastructure,
like a huge virtual server, a number of computer systems are linked together as a large resource base to provide IT services. Since cloud computing is a virtual resource, it is not subject to the restrictions of the remote or local computers. The large demand for storage capacity in cloud computing will drive the needs on disk array applications[^5][^6].

The cloud computing technology is employed to the network services, such as search engine, and Internet mail. The users just need to input simple instructions, and then they can get a lot of information. Therefore, more and more application services through cloud computing can be developed for the future mobile devices such as smart phones, and satellite navigation equipments[^7][^8].

### 2.2 E-Learning

According to the definition of American Society for Training and Development (ASTD), E-learning is the process of the learners applying digital media to learning, and digital media include the Internet, enterprise network, computer, satellite radio, tapes, videos, interactive TV, and CD-ROM. Moreover, the applications include web-based learning, computer-assisted learning, virtual classrooms, and collaborative learning[^9].

The E-learning is a way to learn through the Internet. However, it represents not only Internet plus learning, but also the variety of the ways for learning contents delivery, learning experience management, and networked learning community as well as the textbook content providers and experts. In other words, the E-learning represents not only a new way of training, but also a brand new learning experience. It contains the implications in deeper knowledge sharing, social interaction, and knowledge management for the learning of businesses, schools or individuals. The teaching and training can be implemented on the fast and resource-rich network learning environment to achieve the objective of knowledge acquisition and performance improvement[^10]. The summarized characteristics of the E-learning are: (1) it is a distance learning mode; (2) it is the use of digital learning resources; (3) it is the main user interface of the Internet; (4) satellite broadcast, interactive TV, CD-ROM teaching, Internet, etc. can be used to send materials; (5) it can be synchronous or asynchronous learning and training method.

### 2.3 Theory of Learning Hierarchy

The famous American psychologist and master of education, science and technology, Robert Gagne, thought that learning is not a simple subject; any kind of learning theory cannot explain all the learning natures, for instance, learning a foreign language and learning to read are not covered by a single learning theory. Therefore, learning originates from the complexity and variability of human learning, and then a theory to analyze and explain the diversity is developed. Thus, the fusion of the theory of behaviorism and cognitive psychology covers the diversity of human learning. Moreover, it links the teaching activities and individual learning process to develop their conceptual theory[^11].

Gagne participated in the Air Force in World War II and joined psychological research projects. He also committed to the development of test tools for aviation personnel actions and perceived military training experience. Therefore, he applied the analysis tool of the military training program to the study and education after the Second World War, and he also engaged in the study of mathematical problem solving. However, it was found that the reason why the student cannot solve math problems, because of the lack of certain procedural knowledge. Based on the analysis on the mathematics, the theory of learning hierarchy was developed[^12].

For learning objectives, Gagne used the concepts of Bloom et al. on cognitive, affective, skills, goals, to further subdivide them into five learning results, including: mental skills (intellectual skills), cognitive strategies, language and literature (verbal information), motor skills and attitude. In addition, Gagne pointed out that the internal and external learning conditions of each learning outcome are different. Internal condition is prior knowledge and skills as well as nine cognitive learning stages. External condition is a design of the teaching activities to support the learners’ cognitive processes. The above two conditions use the information processing model to explore the process of learning, and emphasize on close coordination between the teacher’s instruction and internal and external conditions of the students[^13].

### 2.4 Testing and Assessment

Testing is the teaching assessment process, which is commonly used as a tool or method to assess learning outcomes of the students. These assessment tools or assessment methods are used to confirm whether the purpose of assessment achieves the intended learning objectives, and the tool or method itself is not the learning goal. Even though the assessment tools or methods are repeatedly used, it cannot guarantee the learning objectives will be reached, but obtain the updates of learning progress[^14][^15]. Therefore, in order to ensure fulfillment of the learning objectives, we cannot only implement the assessment. After obtaining the messages from the assessment, we also need to implement further remedial instructions or self-correction learning in order to make the diagnostic messages from the test or assessment be fully utilized, and furthermore to achieve the purpose of the “feedback” message to the teaching mod[^16][^17].

### 3. Research Methods

In this study, the E-learning platforms of the learning styles and ability grouping, learning materials and learning unit test assessment and remedial instruction for 3- to 6-graders of an elementary school in Nantou County,
Taiwan are integrated into a E-learning assessment and remedial instruction cloud, and a single E-learning portal is established to reduce the digital learner’s learning threshold. Besides, the cloud system can provide adaptive learning needs to the learners logging to the E-learning assessment and remedial instruction cloud. It can reduce the difficulty of the E-learning platform construction via establishing E-learning assessment and remedial instruction cloud model architecture. The E-learning cloud model architecture diagram is shown in Fig. 1.

3.1 Research Scenario

There were sixty 3- to 6-graders of an elementary school in Nantou County participating in the experiments of this study. Those sixty students were divided into an experimental group and a control group with 30 students in each. The students of experimental group were instructed by cloud-based E-learning assessment and remedial tutoring system for Chinese idiom self-learning, and the students of the control group were instructed by conventional learning to read. Finally, this study made the questionnaire verified by the experts and scholars. Through the questionnaire survey on student learning and learning behavior, statistical analysis was implemented to determine the learning effectiveness of the students of those two groups. In addition, the comments and unsatisfied parts were included as reference for future improvement of the system.

3.2 Structure of the Proposed System

A. Structure of Cloud-Based E-Learning Assessment and Remedial Tutoring System

The proposed system is built in the Windows 2008 Server R2 environment using VMware vSphere and Visual Studio 2010 C# to construct a cloud-based E-learning assessment and remedial tutoring platform. The main purpose is to construct the learners’ learning materials classification, adaptive test assessment, and the remedial instruction E-learning integration platform. This platform provides the synchronization management functions of the learning materials, so the learners’ can execute learning materials synchronization among multiple machines, as shown in Fig. 2.

Fig. 1. Architecture of E-learning assessment and remedial tutoring cloud model.

Fig. 2. Cloud-based E-learning assessment and remedial tutoring system diagram.

B. Learning Framework of Cloud-Based E-Learning Assessment and Remedial Tutoring System

The cloud-based E-learning assessment and remedial tutoring platform design concept is to adopt scaffolding learning. After the learners logging into the learning platform, the learning styles of the learners will be determined by the learning styles cloud, and the learners can select their class category according to their learning styles. The learners will be provided adaptive learning materials via adaptive learning materials database, and with the appropriate context resources to increase learning fun for the learners. After the learning unit test assessment, remedial learning materials and activities for remedial instruction will be provided, and the learning assessment data are stored to the learning portfolio database as the next learning improvement. The system offers various categories of learning for the learners to choose according to their personal preferences, and also provides scaffolding learning path, and it will determine whether the learners need to get into the assessment test, until the end of the learning. The learning path conceptual diagram is shown in Fig. 3.

Fig. 3. Learning path concept map of E-learning assessment and remedial tutoring system cloud.
3.3 Experiment Design

The experimental teaching curriculum is planned according to the purpose of this study. The instructions are divided into two groups, the experimental group uses the platform developed by this study to implement the cloud-based E-learning assessment and remedial tutoring in Chinese idioms, and the control group uses traditional reading course instruction. The curriculum and teaching activities of those two groups are illustrated below.

A. Teaching Curriculum of Experimental Group

In this study, the textbooks of Chinese idioms and similar words compiled by the Ministry of Education are selected as the teaching materials. The course levels and cloud-based E-learning assessment and remedial tutoring platform are designed according to the theory of learning hierarchy proposed by Gagne.

(1) To design course levels based on the learning hierarchy proposed by Gagne: Gagne believes that learning is the result of the interaction between the learners and the environment that causes learning conditions falling into two categories.

a) The internal conditions: students’ prior knowledge and ability. Before the pretest, 100 words are selected to test. The test results categorize the students’ learning styles into eight, they are: learning accessibility, shape obstacles, shape and homophone obstacles, homophonic word disorders, homophones, words and semantic barriers, linguistic barriers, shape and semantic disorders, and shape, sound and meaning obstacles.

b) External conditions: learning environment, teachers control and arrange eight learning levels. (a) Symbolic learning: learning explanation of basic idioms, example sentences and similar words, opposite words, and idioms within the scope of the course. (b) Stimulus-response learning: using cloud-based E-learning assessment and remedial tutoring platform for teaching students in accordance with the idioms sentences and similar words classification, giving rewards when the classification is successful, and enhancing the students’ willingness to learn idioms. (c) The chain reaction: two or more courses of study to complement each other, learning the principles of idiom interpretation, sample sentences, and similar words. (d) The language linkage learning: linking and classifying more than two idioms. (e) Multiple discrimination learning: learning many different stimuli for idioms, and making the different appropriate responses. (f) The concept learning: classifying the same idiom by its properties, and learning idioms explanation, example sentences, and the principles of similar words. (g) The principle learning: understanding the relationship between two or more similar words. (h) Problem-solving learning: utilizing the principles of shape, sound, and meaning in difficult words self-study.

(2) Teaching activities: according the test results based on the internal conditions, the students of different learning styles are given adaptive teaching content and teaching activities. However, learning condition of each student is different, and the students of the same learning style should also be given adaptive learning contents. The remedial tutoring will be given according to pre-test results of the students. The students will be given different learning contents due to different grades, different learning styles, and different wrong-answer questions. Therefore, this study applies eight learning levels of the external conditions to design eight teaching activities units, and the teaching contents of the activities are based on the eight different learning styles of the internal conditions.

(3) Online learning materials: in response to the learning needs of the students of different learning styles, the unit content of each teaching activity is based on idioms and similar words as the main learning materials and the multimedia animation materials of eight different learning styles are designed to provide learning activities for the students on the cloud-based E-learning platform.

(4) Unit remedial instruction: after the learning activities in each unit, the students are required to undergo a learning test to examine the learning achievements of the students in the activities of this unit. When the students complete the test sheets, the system will send an answer feedback screen display of learning test scores, and remind the students with the score lower than the standard. The students need to join the remedial instruction activities of this unit, and the remedial instruction teaching materials will be presented separately for different unit activities. There is a variety of learning styles of learners to remedial instructions, and the students can re-learn to achieve the required standard before entering another unit of learning activities.

B. Control Group Teaching Course

The students of control group also have basic understanding of idioms and similar word, and have self-learning ability on idioms explanation, sentences and similar phrases, and the opposite phrases. The teaching course contents and the teaching activities are exactly the same as those of the experimental group; the main difference is that the materials are presented purely in traditional approach to teach and learn. After the end of each learning activity, the learning sheet is used instead of the traditional test assessment, the learners can participate those two learning activities to achieve the effect of review.

3.4 System Implementation

In this study, after the completion of the cloud-based E-learning assessment and remedial tutoring platform, the experimental group students in a computer classroom
implement the cloud-based E-learning courses, and the students can complete the learning activities based on the individual’s learning progress. Before implementing cloud-based E-learning course, the students need to take the pretests to assess their learning styles, and they can get into the learning unit directly based on their learning styles.

There are a total of eight teaching activities units in the teaching materials. In addition, there are multimedia animation learning materials in each activity unit, as shown in Fig. 4 and Fig. 5. After a unit of study, the students are required to undergo unit quiz. If the score does not reach the standard of the students in each unit quiz scores (85 points), the students need to enter the remedial instruction activities of the learning unit. Conversely, if the student has reached a standard score, the students can go to the next new learning activity units.

4. Research Results and Performance Analysis

4.1 Comparisons of Learning Achievements between Two Groups

The pre-tests and post-tests of the students of both groups are taken to compare the difference between the learning outcomes of two different course teaching methods, which are cloud-based E-learning assessment and remedial instruction, as well as traditional reading to learn. After the instructional experiments of two course teaching methods, the learning performance analysis on the pre-test and post-test results of the experimental group and the control group is implemented by the statistical product and service solutions (SPSS) statistical analysis software. In the learning performance analysis, the paired sample statistics of the experimental group and control group are listed in Table 1.

Moreover, the t-test is used to compare the differences of mean values between the pre-test and post-test of those two groups, and the results are shown in Table 2. The pre-test and post-test scores in the experimental group mean values are 81.83 points and 72.00 points, respectively, the p-value of this paired sample t-test is 0.000<0.050, the results reach the level of significance, which means that prior to the students of the experimental group, there is a significant progress in the post-test scores. The pre-test and post-test scores in the control group mean values are 75.83 points and 72.33 points, respectively. The results are slightly progressive trend, the p-value of this paired sample t-test is 0.070>0.050, the results do not reach the level of significance, which means that the post-test mean score of the control group students has been improved, but there is no significant difference.

4.2 Analysis of the Learners of Different Learning Styles

The difference of the learning achievements before and after the cloud-based E-learning courses is obtained through pre-test and post-test. The paired sample t-test is used to compare the differences of mean values between the pre-test and post-test of the students of different learning styles in order to know whether the students of different learning styles can enhance their learning achievements through cloud-based E-learning courses.

As shown in Table 3, the p-value of the paired sample t-test is less than 0.050 in each learning style, which means that there is significant difference between the pre-test and post-test for the students of learning style (1, 2, 3, …, 8).

Table 1: Paired sample statistics of experimental group and control group

<table>
<thead>
<tr>
<th>Test</th>
<th>M</th>
<th>N</th>
<th>SD</th>
<th>SEM</th>
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<tr>
<td>Experimental group</td>
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<tr>
<td>pre-test</td>
<td>81.83</td>
<td>30</td>
<td>8.952</td>
<td>1.634</td>
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<tr>
<td>post-test</td>
<td>72.00</td>
<td>30</td>
<td>13.620</td>
<td>2.489</td>
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<tr>
<td>Control group</td>
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<tr>
<td>pre-test</td>
<td>75.83</td>
<td>30</td>
<td>12.804</td>
<td>2.338</td>
</tr>
<tr>
<td>post-test</td>
<td>72.33</td>
<td>30</td>
<td>13.309</td>
<td>2.430</td>
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</tbody>
</table>

Table 2: Results of the paired sample t-test for experimental group and control group

<table>
<thead>
<tr>
<th>Test</th>
<th>M</th>
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<th>SEM</th>
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<tr>
<td>Experimental group</td>
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<td>pre-test and</td>
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<td>experimental group</td>
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<tr>
<td>post-test</td>
<td>9.833</td>
<td>6.628</td>
<td>1.210</td>
<td>8.125</td>
<td>29</td>
<td>0.000</td>
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<td>Control group</td>
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<td>pre-test and</td>
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<td>control group</td>
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<tr>
<td>post-test</td>
<td>3.500</td>
<td>10.184</td>
<td>1.859</td>
<td>1.882</td>
<td>29</td>
<td>0.070</td>
</tr>
</tbody>
</table>
4.3 Learning Attitude Comparisons between Pre-Test and Post-Test

In this study, the survey on the learning attitude for the students of the experimental group is implemented. There are a total of 10 questions in the survey questionnaire. The results of the survey analysis show that 65% of the students using the cloud-based E-learning to learn Chinese idioms tend to be positive and about 20% students have few changes in learning attitude. Apparently, the step-by-step and easy-to-difficult pedagogy can effectively change the attitude of the students in idioms learning, and it is conformed to Gagne’s learning hierarchy theory. In this study, the satisfaction survey on the cloud-based E-learning assessment and remedial tutoring platform for the students of the experimental group is implemented. The results of the survey analysis reveal that nearly 80% of the students enjoy and benefit from the study using cloud-based E-learning courses. It can be seen that the students have high interest in reinforcement learning, thus it will improve the interest in learning Chinese idioms, and it is conformed to Gagne’s learning hierarchy theory.

4.4 Satisfaction Survey Results Analysis of Students and Teachers

After completion of the cloud E-learning course, the students of the experimental group directly fill out the student satisfaction questionnaire for the cloud-based E-learning platform in this study. There are 15 questions in this questionnaire. Moreover, 5-point Likert scale is adopted by the questionnaire to let the user select their degree of satisfaction for each question according to actual using situation, the maximum score is 5, and the lowest score is 1. According to the satisfaction questionnaire data results, we can see that the students are highly satisfied with this cloud-based adaptive testing assessment and remedial tutoring system, and 90% of the students in total combined percentage of very satisfied and satisfied with the system. In this study, after the completion of the cloud-based E-learning materials, the teachers, experts, and scholars are invited to observe the system usage, and interview the teachers, during the process of teaching experiments. Most of the teachers, experts, and scholars are satisfied with the system. Moreover, they think the system is helpful for teaching and learning.

5. Conclusions

The main objective of this study is to effectively use cloud-based E-learning resources integration and sharing, as well as to improve the performance of E-learning. Therefore, the E-learning platforms of learning styles, learning materials, learning units, test assessments, and remedial instructions in the Chinese idioms and similar words are employed to integrate an E-learning assessment and remedial instruction cloud. The system cloud will provide the E-learning platform the learners need, and improve the flexibility of E-learning. The learning styles of learners are classified by the E-learning assessments and remedial instructions cloud via cloud computing. The E-learning cloud-based platform can provide the learners adaptive E-learning unit teaching and learning activities, so that the E-learning platform can meet the learning needs of each learning style. The cloud-based E-learning assessment and remedial tutoring platform is used to evaluate the learning performances of learners, and the remedial instructions on the misconceptions are implemented to improve the learning effectiveness of learners. In addition, the results of this study can not only enhance students’ Chinese idioms self-learning interest, but also provide other E-learning research as a reference in the cloud-based E-learning platform construction.

References


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