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Individual learner big data based cloud role player game learning

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Abstract. In this research, an Individual Learner Big Data Based Cloud Role Player Game Learning Corresponding to Individual Learner Big Data is proposed. Based on the proposed platform, all the learning states and information (Big Data) of individual learner can be further analyzed. By using dynamic assigning algorithm, individual learner (student) can be separated into different levels related to the learning ability. According to dynamic assigning algorithm, student's answering times and answering correct rate of each education scenario in the proposed cloud based digital game learning system is considered. Then, suitable teaching scenario will be provided for individual user corresponding to personal learning ability. Each designed modular teaching scenario can be embedded into the game platform on the virtual machine in cloud. The information about students in the game learning system can be stored in the cloud database. In addition, the whole learning system is established as a virtual machine. System maintainer can configure the learning system easily and quickly. Based on cloud, different remote devices can connect to server for learning.

Keywords: Cloud computing, virtualization, RPG, game-learning, virtual machine, dynamic assigning, digital game

1. Introduction

Today, many countries focus on the multimedia for providing learning or education content to different people. The research [3] presented that the motivation of learning can be obviously enhanced via learning based on digital games. It also means that learners or students would have higher interest in playing learning-game [19].

The digital learning game player or students, who would pay more attention to the learning game, would have higher motivation to find or learn the problem solving knowledge in playing game. In other words, if the problem solving knowledge can be the key of the learning game mission, problems, stages, or scenarios, individual learner or student can be guided to learn the key knowledge [1,2,20].

In the past, most learning systems are based on the "question and answer (Q&A)" type to teach the students [8–10]. After questioned by questions, the learner has to select the correct answer to prove the learning ability. However, this type of learning games will be strict and inflexible with the content. The learning procedure is similar to the original textbook type learning. Without differences between digital and paper learning, the learners will lose their motivation easily and quickly. Finally, the performance of learning cannot be enhanced.

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Today, to use multimedia or game as the learning system [17] is a good solution to have the students' attention and motivation in learning. Due to the increasing motivation and interest, the self-advanced learning becomes more possible or can be achieved. According to the education theory, from basic to complicated, the self-advanced learning by using multimedia or playing game can be enhanced [18].

To make the learning based on game to be more popular with all students or learners, the learning system or game platform should not be too hard to install. In opposition, the learning platform or game platform should be as easy as possible. However, currently, there exists different hardware such as PC, pad, mobile phone, which may cause the performance of the learning system reduced or failure. Hence, the learning system or game platform provider should reduce the complexity for students with different hardware and operation systems. To solve the problem, ubiquitous computing and cloud platform are good solution which can be used to establish the remote virtual server.

Today, the ubiquitous computing is used to collect information or big data everywhere and anytime [7]. Due to the character of cloud computing, data or big data stored in the cloud environment can be immediately accessed everywhere and anytime. Furthermore, the cloud environment can allow users to employ applications without configuration or with less installation procedure [7,11,12]. Therefore, by providing learning system services based on the cloud environment, students can obtain the learning services directly via Internet connection without extra installation or configuration. Corresponding to different students or learners, the virtual machine (VM) based on cloud which without clients' manual configuration can be more easily managed and maintained. Each virtual machine can be established for individual users as wish. In addition, considering the total amount of big data and information collected from the learning system, to deal with the big data for mining will need computing resource such as huge memory size, distributed and parallel computing, storage space, etc. The cloud computing today can provide the on demand required computing resource. Hence, in this research, the cloud computing environment is used for the game-learning system.

The main contributions of the proposed game learning system are as follows:

- The learners' information and states are recorded as the on demand format and storage based on the cloud database. All the information or big data can be dynamically managed and computed to tune the state and limitation of the learning level classification. By collecting more information or big data from different learners, each student or learner can be evaluated more objectively. In addition, the teaching content or game scenario can be also evaluated more fairly.
- Based on the proposed dynamic assigning algorithm, the learning ability and state (big data related to personal ability) of each student or learner can be individually identified and recognized. Then, the proposed game learning system can enhance the learning performance of individual users according to evaluation result based on the proposed dynamic assigning algorithm.
- According to the scenario creation procedure, the game mission solving scenario can be designed and used instead of question or quiz type learning. Furthermore, individual independent scenario can be merged into another one bigger game learning platform.
- The learners' data or information is independent from the any game scenario of the learning system. After playing or completing any game learning scenario, this game learning scenario can be initialized for any other learner. In other words, the privacy of learner can be secured and the cost of managing the entire learning platform can be decreased.
- The individual continuous assessment of a game-learning player can be also collected and recorded. Since the all the game learning including the teaching content and learning scenario are digital and stored in a database, the teacher or director can observe the ability and potential of an individual student.

– The learning game can be easy to use. The learning platform users or learners can use any device such as mobile phone, pad, or PC to connect to the proposed platform for the learning resource. According to the designing principle of vertical curricular organization, each player or student can be encouraged and pay attention to continuous learning.

This research is organized as follows. In Section 2, the development of the proposed learning system is described. In Section 3, the proposed Dynamic Assigning Algorithm of the learning system for managing the big data integrated with cloud computing is presented. The verification and experiment result are shown in Section 4. Finally, a conclusion is presented in Section 5.

2. The development of modular role player game (RPG) distance learning system

Since game learning has many advantages, to adaptively design the learning game system becomes an important issue. The mission purpose or the problem solution of each designed game scenario should be corresponding to the objective of the educational teaching content or purpose. In this research, a mission, game branch, or scenario of the game is called an Act. Each Act can be a question or purpose for learning. After creating an Act, each Act can be individually played as a small e-learning game. Or several Acts can be integrated or merged as a larger game scenario. Figure 1 presents the concept of the modular scenario design procedure for the proposed game learning. To create the Acts, the designer has to do the following:

– The designer has to develop the scenario or drama of the game unit. According to the design tool, several scenes or game events of the entire learning scenario called Acts can be connected or integrated.
– The designer can separate the drama into several scenes (partitions of the scenario). Each Act consists of characters, music, and mission events (conversation topic) which are determined according to different conditions and backgrounds.
– The mission events of the scenario should be designed according to the demand or achievement of the teaching content. Especially, the on demand defined answer should be as clear and unique as possible.

Based on the vertical curriculum organization and game playing process, each partial game or Act should be corresponding to the principles which include:

– Learning from simple to complex.
– Learning from familiar with to not familiar with.
– Learning from concrete to abstract.
– Learning from whole to part.
– Learning from the past to now.
– Learning precondition study first.
– Learning concept association method.

Therefore, players could learn through the game step by step without frustration and depression. Furthermore, the potential of an individual player or learner can be found and enhanced.

When a learner starts to play the proposed learning game, considering characteristics of each student or learner, only the suitable games or corresponding game scenario can be triggered. The game learning system will evaluate the player according to the past learning records and big data. If the on-demand given conditions of the mission (or Act) or the pre-learning content (or game scenario) completion

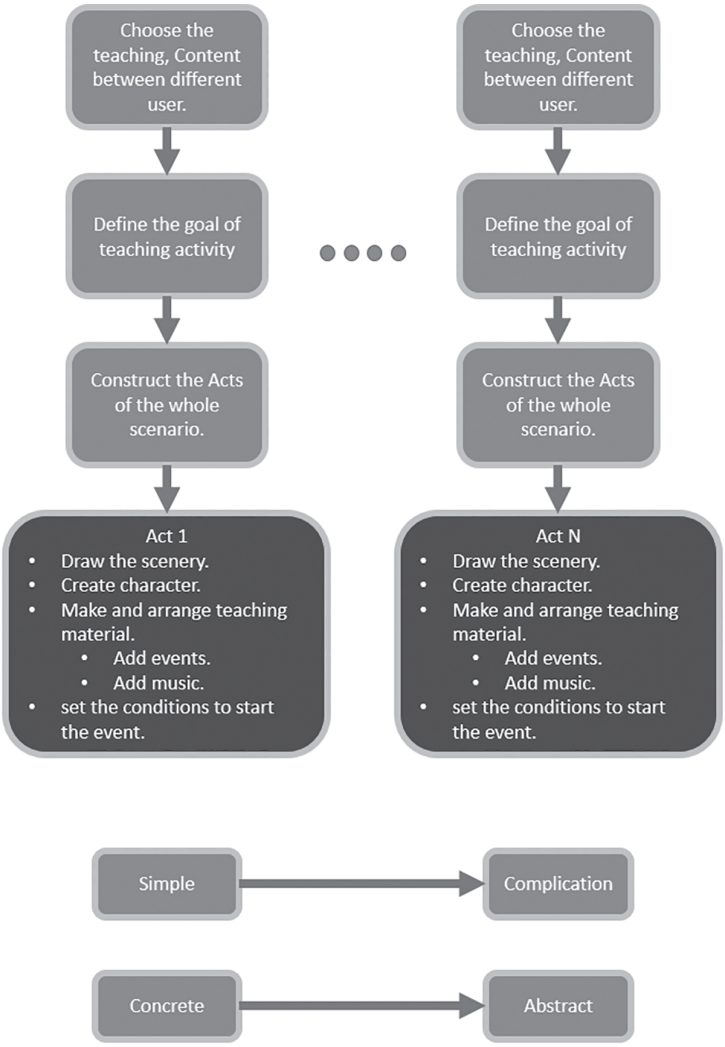

Fig. 1. The standardized and modular e-learning game Act creation procedure based on vertical curriculum organization principles.

cannot be satisfied, the student or learner cannot trigger the further learning mission. In other words, the learner should spend more time for the current learning content. Only when the learner satisfies the test of the current learning course (or Act), the student or learner can complete the current mission and trigger the further learning content. According to the recognition result, the learner can be evaluated. If the teaching objects are satisfied, there will be a reward for the player such as a character level upgrade, obtaining new or finite items, etc. At the same time, the current information and continuous assessment can be updated for that player.

Teaching events will be given to the student step by step according to the following education theory:

- The students' learning motivation can be enhanced.
- The student will be given a goal of this course similar to the on-demand mission completion conditions of the game.
- A student will be trained, taught, and examined.

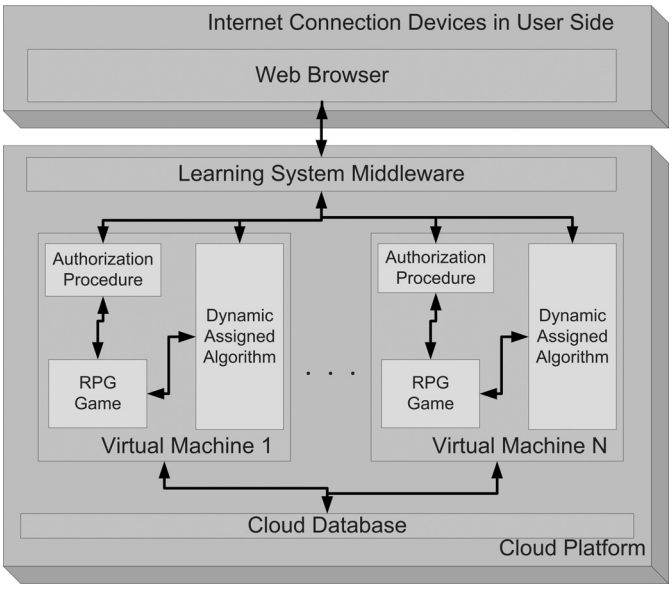

Fig. 2. The structure of the proposed system.

– Only when the student passes the examination which is similar to the player satisfying the mission conditions of the game, the student can be identified as one who possesses the knowledge of this course. Then, students could keep learning this way again and again.

Since the cloud computing platforms today are popular [4–6,13–16] the Internet based services can be used for remote client user via any devices. By using the web browser, the cloud user can login the virtual machine for further operation. In addition, every time the cloud user disconnects the virtual machines, the resource for computing will be returned to the resource pool for reusing. Furthermore, by configuring the image file of the virtual machine; the virtual machine can be initialized and repeatedly used. Therefore, the learning system can be deployed on cloud for multiple users and for repeated using. In addition to the main learning system, the information related to learners can be also recorded in the database on cloud. In other words, the learning system's users only need the devices which have the Internet connection to the cloud without further configuration. It also means that the learning characteristics and parameters of the user recorded in the remote database can be transmitted between the learning game and the third party applications used in school. In other words, via the Internet, the system user can obtain the game-distance-learning service anytime and anywhere.

The structure of the whole proposed system is shown in Fig. 2. System users use the devices based on Internet connection for interaction with the virtual machine on cloud. To enhance the proposed system, the third party applications can also connect to the proposed learning system for learning state querying. All the remote connection should be authorized as the valid connection by using authorization procedure.

3. Algorithm, verification and implementation

3.1. Dynamic assigning algorithm

Since the learning abilities of different learners may be different, to adaptively provide the suitable learning content corresponding to the individual learner is important. In this paper, the proposed dynamic

Table 1
Definitions of parameters used in algorithm

Parameters	Definition
Q	Number of question
P	Number of person
Q_C	Correct number of question
R_C	The correct rate of current exam
R_{CH}	Defined high correct rate of current exam
R_{CM}	Defined medium correct rate of current exam
R_{CL}	Defined low correct rate of current exam
T_P	Personal testing time of current exam
T_A	Average testing time of current exam
Q_H	Number of Level A question
Q_M	Number of Level B question
Q_L	Number of Level C question
P_H	Number of Level A person
P_M	Number of Level B person
P_L	Number of Level C person
T_{AH}	Average testing (spending) time of Level A
T_{AM}	Average testing (spending) time of Level B
T_{AL}	Average testing (spending) time of Level C
k	All of chapter
i	Each of chapters
α	Higher reference value
β	Lower reference value
Dp	The data set of p^{th} user
dpi	The i^{th} chapter learning data of p^{th} user
L_p	The learning state and level of p^{th} user

assigning algorithm for individual learner is used based on the ratio of correct answer and the total testing time of individual learner. Hence, the proposed dynamic assigning algorithm can on-demand provide the suitable further learning content based on the past learning state of individual leaner and the past evaluation result of the further learning content. The parameters of proposed dynamic assigning algorithm are given as Table 1.

3.1.1. Step 1: Big data management

When individual learner use the digital game-learning system, the learning state of learner will be recorded in the database in cloud. The data recorded in the cloud database (HBase) is based on the structure of Hadoop Data File System (HDFS), a NoSQL type database. All the data of individual learner will be flushed as several blocks or called HFile. Each block is limited as 64 MB.

Considering different objects or chapters which learners may trigger, each learning data of p^{th} user will be denoted as dpi. In other words, if there are many system users (learners), the dpi data will be huge and dynamically transmitted from different users. A dpi data consists of Q_{cpi} and T_{pi} as dpi $= Q_{cpi}, T_{pi}$ which indicate the correct number of question and personal of testing time in i^{th} chapter corresponding to p^{th} learner. By using Q_{cpi} and T_{pi} as the key, the related value such as average correct answer rate, average testing time, etc., can be evaluated and calculated. In other words, according to the big data collected from the proposed system, each learner (student) can be classified as the suitable level corresponding to the most learners' learning state or learning ability.

According to the individual learning content (game scenario), all the learners can be divided into three levels: Level A, Level B, and Level C. The levels indicate the learning state or situation of individual leaner. Hence, after sorting the grade of all learners, each learning content or scenario can be on demand

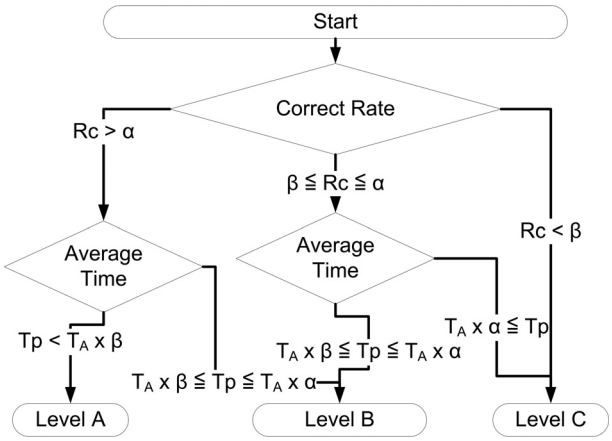

Fig. 3. The flowchart of Normalize (Initial) Algorithm.

given the reference value α and β such as 70% and 30% based on the grade distribution of learning state or situation. By sorting all grade data, the high correct rate of the exam (corresponding to the learning content or scenario) can be obtained as R_{CH} (70% higher than other learners). In addition, the value of R_{CM} and R_{CL} can be also defined.

Similar to the correct rate of each learning content or scenario, by sorting and calculating all data of personal testing time, the average time of testing, T_A, can be obtained. According to the testing time and the correct rate of the exam, each teaching scenario or content will be given the corresponding degree of difficulty. Furthermore, the three levels: Level A, Level B, and Level C in each teaching scenario or content will be also defined and separated. In other words, the average testing time of Level A, Level B, and Level C can be obtained as T_{AH}, T_{AM}, and T_{AL}. Based on these evaluation values from big data, each learner and teaching scenario can be evaluated more fairly.

3.1.2. Step 2: Normalize (Initial) algorithm

However, the learner who first plays the learning game cannot be classified according to the past learning data. Hence, a new learner will be given a initial test. Suppose that there are total Q questions. Then, Q_c indicates the total correctly answered questions of user. The proposed algorithm can evaluate and obtain the value of the correct rate. Based on the α, β value given based on the big data and education theory, whole the students or learners can be divided into three levels: High learning ability (Level A), middle learning ability (Level B), and low learning ability (Level C).

Shown in Fig. 3, considering both the answering time of the test and the rate of the correct answer in the test, the higher correct rate with less spending time will be classified as the high learning ability level (Level A). However, if the learner spends too much time for high correct rate, the algorithm will classify this learner as middle learning ability (Level B). Similar, the learner has middle correct rate with too much answering time or only low correct rate will be classified as the low learning ability (Level C).

Therefore, every player can be classified in the beginning. Then, system will divide player into three different degrees. After classification, the corresponding learning scenario can be provided to each learner. In other words, the suitable learning content (playing scenario) can be provided to individual leaner. A learner needn't to face the too hard or too easy learning content. The classification algorithm is shown as Table 2.

Table 2
The evaluation of dynamic assigning algorithm

Normalize (Initial) Algorithm

Input: (Q_{cpi}, T_{pi})
Output: L_p
$R_{cpi} = Q_{cpi}/Q_i$
$T_{Ai} = 0$
$R_{Ci} = 0$
for $p = 1$ *to* M **do**
$T_{Ai} = [T_{Ai} \times (i-1) + T_{pi}]/i$
end for
for $p = 1$ to M **do**
$R_{Ci} = [R_{ci} \times (i-1) + R_{cpi}]/i$
end for

if $R_{cpi} > R_{CHi}$
  if $T_{pi} < T_{Ai} \times \beta/0.5$
   return $L_p = A$
  else if $T_{Ai} \times \beta/0.5 < T_{pi} <= T_{Ai} \times \alpha/0.5$
   return $L_p = B$
  else
   return $L_p = C$
  end if
else if $\alpha \geqq R_{cpi} \geqq \beta$
  if $T_{pi} \leqq T_{Ai} \times \alpha/0.5$
   return $L_p = B$
  else
   return $L_p = C$
  end if
else
  return $L_p = C$
  end if
end if

Table 3
The evaluation of dynamic assigning algorithm

Dynamic assigning algorithm

Input: (L_p, Q_{cpi}, T_{pi})
Output: L_p
if $L_p = A$
$R_{cpi} = Q_{cpi}/Q_{Hi}$
  if $R_{cpi} > \alpha_i$
      if $T_{pi} \leqq T_{AHi} \times \beta_i/0.5$
       return $L_p = A$
       else
      return $L_p = B$
       end if
   else
      return $L_p = B$
   end if
else if $L_p = B$
$R_{cpi} = Q_{cpi}/Q_{Mi}$
  if $R_{cpi} > \alpha_i \,\&\&\, T_{pi} \leqq T_{AMi} \times \beta_i/0.5$
   return $L_p = A$
  else if $\beta_i < R_{cpi} \leqq \alpha_i \,\&\&\, T_{AMi} \times_i /0.5 \leqq T_{pi} < T_{ALi} \times \alpha_i/0.5$
   return $L_p = B$
  else
   return $L_p = C$
  end if
else if $L_p = C$
$R_{cpi} = Q_{cpi}/Q_{Li}$
  if $\beta_i < R_{cpi} \leqq \alpha_i \,\&\&\, T_{ALi} \times \beta_i/0.5 \leqq T_{pi} < T_{ALi} \times \alpha_i/0.5$
   return $L_p = B$
  else
   return $L_p = C$
  end if
end if

3.1.3. Step 3: Dynamic assigning algorithm

However, not every learner can maintain the learning ability as the level classified in Normalize (Initial) Algorithm. Some learners will be improved and will have higher learning ability. Of course, some students' learning ability will be degenerated due to the complexity of learning content. Therefore, in this research, the Dynamic Assigning Algorithm is proposed.

To suitably evaluate each learner, the learning state (or data) should be tracked. In addition, based on the teaching content and education theory, the α and β value given based on the big data corresponding to each teaching scenario will be dynamically changed and given. Hence, each teaching scenario (i^{th} teaching scenario) will be given the related reference value, α_i and β_i corresponding to the big data of the i^{th} teaching scenario with the specific level. In the beginning, the learner may be classified initially or evaluated from the past learning state. Then, the learner will be given (or taught) the teaching scenario corresponding to learner's level. After learning, the learner will have a test (evaluation) of the teaching scenario. Similar to Normalize (Initial) Algorithm, considering the correct rate and the answering time, each learner will be evaluated and divided into the suitable level again. Finally, the learner will begin the new teaching scenario based on the new classification result. Table 3 presents the evaluation of the proposed algorithm.

Based on the proposed algorithm, all players will be allocated taught corresponding to individual player's learning ability. In addition, a learner will be re-classified due to the current learning state.

Too hard or too easy learning content or scenario will not be given to each learner. Furthermore, the advance or not of learning can be observed and evaluated. Each student can have chance to be classified as Level A. Since the teaching content in the game learning system is coherent (from simple to complex, from easy to hard, etc.) based on the education theory, the probability of a learner who is re-classified from Level C to Level A, or Level A to Level C, is very small. Hence, in this research, the extreme level changing is not considered. Therefore, by using the proposed algorithm, learners will not lose their learning interest and passion.

Therefore, when a learner starts the game learning, the personal information will be required (such as ID, password, etc.). Then, the virtual machine based on cloud with the game learning system can be assigned to the valid learner. The game learning system in the virtual machine is completely initialized. Hence, the learning information and state of the valid learner should be provided by the remote database in cloud. After the integration of learner's personal learning information and the initialized game learning system, a valid learner can start or continue the incomplete teaching scenario of the game.

When a learner completes a learning scenario, the game learning system will give an evaluation test in game style. Corresponding the each learner's level which classified by the proposed algorithm, if the answer correct rate is less than the on demand given value, α, of the specific level, the learner is fail to pass the learning scenario at the specific level. Furthermore, if the answer correct rate is less than 0.6, the learner should be re-trained in the lower level again. Hence, only the learner can have the answer correct rate more than 0.6, a learner can be passed to the next learning scenario. In addition, according to the current learning state and information, the level of the next learning scenario can be decided.

3.2. System verification and implementation

In this paper, a game design tool, RPG maker application, is selected to design the game which represents the teaching course for learning. Only when a student's properties or characteristics fit with the on demand condition, the game mission with the next higher degree, which indicates more complexity or more multiple concepts, is triggered. In other words, the properties of an individual student must meet the lowest requirement of the new Act (game mission). Thus, a student (game player) could play and learn the game step by step.

In the implemented game of the proposed system, the student will play a virtual role for the game mission processing. The appearance of each non-player-control virtual role between different users (players) in each individual RPG game will be the same. Different game missions are playable corresponding to the abilities and characteristics of an individual user. Figure 4 shows the flowchart of the proposed cloud game-based learning system. After a user login in the system, the RPG game is started in the virtual machine. After students' end of learning, data will be saved into database, they can keep on learning at next time.

Similar to basis learning by textbooks, the proposed learning system provides a quiz to verify learning situation of students. The quiz provides not only one answer, students can in accordance with approximate own preference to answer that. Simultaneously, the script can follow hobbies of students to improve their learning desires.

The RPG has many functions of permutation and combination, such as we can punish by reset the heal point (HP) or using stamina point (SP) to make some items of task requirements, and the other, we can set restrict of different degrees by degree (LV) to check if students achieved. Figure 5 shows state of learners. After finishing a part of learning, players or students can save learning progress and information into database. In addition, users who have the account number and password or permission can inquire state of students.

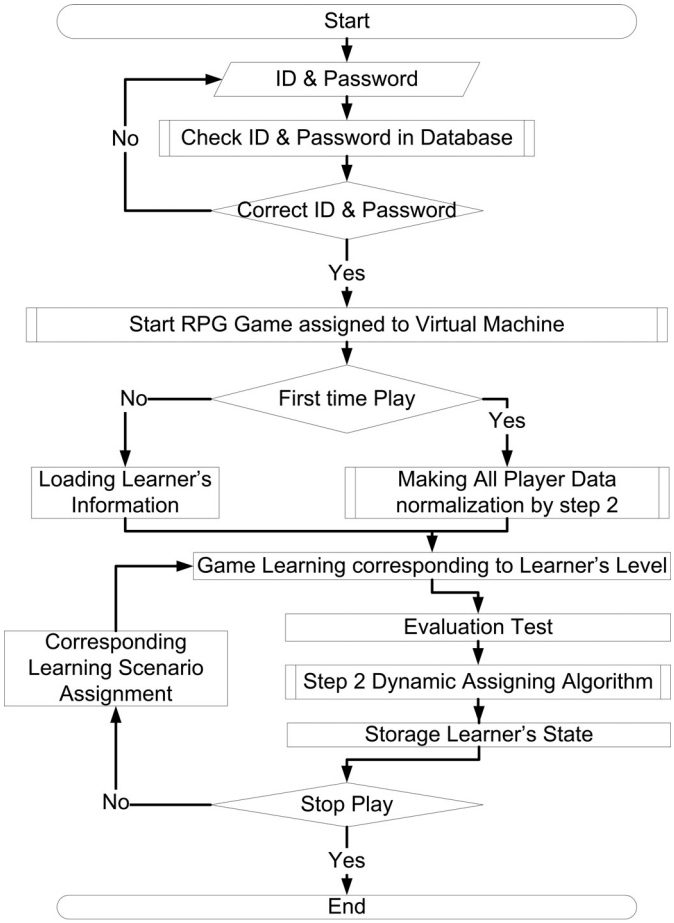

Fig. 4. The flowchart of game-learning system.

4. Result

In this paper, the game learning platform based on cloud is implemented. In addition, the game learning platform is given and used in the elementary school. There are: One student in third grade, four students in fourth grade, and five students in fifth grade. In the beginning, all the students are given the pre-test for level evaluation. Based on the level evaluation result, the students are classified and given the corresponding learning scenario. During the game learning, no teacher is needed or required. All students learn and finish the teaching scenario mission by themselves. Finally, the final evaluation tests are given to each student.

The evaluation results according to the Normalize (Initial) Algorithm of all students are shown as Table 4.

The third grade student has the same correct rate between two evaluation tests. However, even the questions of pre-test and final test are not the same, the student still improves himself and answers the questions with less time. Only 65.5% of original spending time is needed for the same correct rate. Figure 6 shows the learning improvement of the third grade student.

The fourth grade students have more obvious improvement between two evaluation tests. The students who are classified as Level C have the most obvious improvement. Originally, two students cannot

Table 4
The evaluation results according to the Normalize (Initial) Algorithm

	Rank A	Rank B	Rank C
3rd Grade			
Student 1			V
4th Grade			
Student 1			V
Student 2		V	
Student 3			V
Student 4			V
5th Grade			
Student 1			V
Student 2		V	
Student 3		V	
Student 4		V	
Student 5	V	V	

Fig. 5. All states of learner.

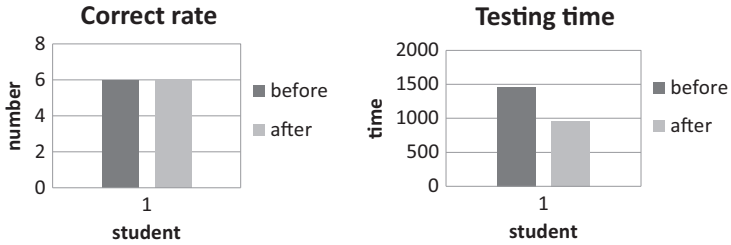

Fig. 6. The learning improvement of the third grade student.

answer any question in pre-test. After learning, these two students can achieve 40 $\sim$ 60% correct rate (origin 0%). Originally, the students classified as Level C would give up the test quickly. After learning, these students would spend time for answering the questions. In addition, the student classified as Level

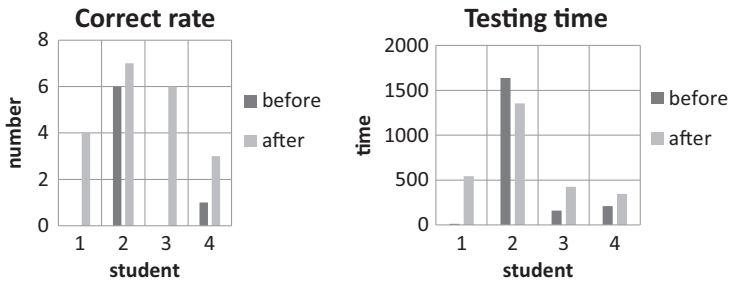

Fig. 7. The learning improvement of the fourth grade student.

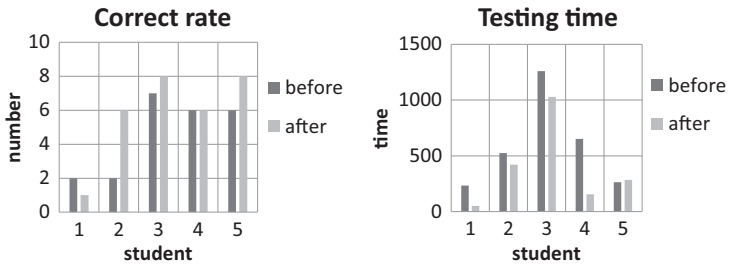

Fig. 8. The learning improvement of the fifth grade student.

B can gain higher correct rate with 82% of original spending time needed. Figure 7 shows the learning improvement of the fourth grade student.

The fifth grade students also have obvious improvement between two evaluation tests after learning based on the proposed game learning system. The students who are classified as Level A or B have the most obvious improvement. After learning, these three students classified as Level B can achieve at most 60% correct rate (origin 20%). Especially, the students classified as Level B only need to spend 24 $\sim$ 82% of original answering time. Even the student classified as Level A can gain 20% higher correct rate with the same answering time. Figure 8 shows the learning improvement of the fifth grade student.

5. Conclusion

In this paper, the cloud game-based learning system with dynamic assigning algorithm in ubiquitous computing is proposed to provide a learning game based on the education theory and vertical curricular organization. Each game-learning user can be identified. Moreover, the information and playing progress can be recorded individually in the database. The learning system is easy to use so that even a primary student with finite IT knowledge can play the learning game. With the dynamic assigning algorithm, we can immediately get level of the students (players) and teachers can also increase for the students' educational ability based on the results of the system. We have also shown that students actually learn the teaching content from the designed game and have obvious progress in the test.

The students not only learn by play the game, their performance, advantages and defect were showed on the website for teacher or themselves easily.

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