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(54) **COMPUTER-AIDED LEARNING SYSTEM AND METHOD**

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This patent is subject to a terminal disclaimer.

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(58) **Field of Classification Search**

USPC 434/118, 322, 362, 353

See application file for complete search history.

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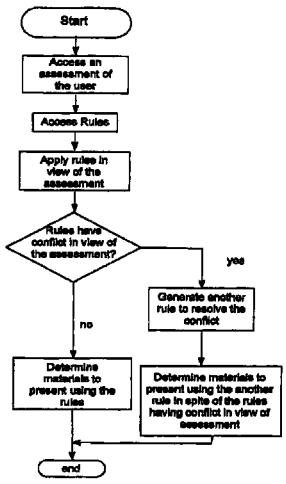
(57) **ABSTRACT**

A computer-aided learning method and apparatus based on a super-recommendation generator, which is configured to assess a user's or a student's understanding in a subject, reward the user who has reached one or more milestones in the subject, further the user's understanding in the subject through relationship learning, reinforce the user's understanding in the subject through reviews, and restrict the user from enjoying entertainment materials under certain condition, with the entertainment materials requiring a device to fulfill its entertainment purpose. The generator does not have to be configured to perform all of the above functions.

16 Claims, 10 Drawing Sheets



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continuation-in-part of application No. 08/618,193, filed on Mar. 19, 1996, now Pat. No. 5,779,486, and a continuation-in-part of application No. 08/633,582, filed on Apr. 17, 1996, now Pat. No. 5,743,746, and a continuation-in-part of application No. 08/664,023, filed on May 28, 1996, now Pat. No. 5,727,951, and a continuation-in-part of application No. 08/675,391, filed on Jul. 2, 1996, now Pat. No. 5,863,208, and a continuation-in-part of application No. 08/707,189, filed on Sep. 3, 1996, now Pat. No. 5,743,743.

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Blackboard Inc.'s Reply Brief in Furth Support of Its Motion for Reconsideration, C.A. No. 1:11-CV-00876-RGA, filed Jul. 10, 2014, pp. 1-9.
IpLearn's Response Brief in Opposition to Blackboard's Motion for Summary Judgment, C.A. No. 1:11-CV-00876-RGA, filed Aug. 7, 2014, pp. 1-44.
Exhibit 5, IpLearn's Response Brief in Opposition to Blackboard's Motion for Summary Judgment, C.A. No. 1:11-CVf-00876-RGA, filed Aug. 7, 2014, pp. 1-5.
Exhibit 6, IpLearn's Response Brief in Opposition to Blackboard's Motion for Summary Judgment, C.A. No. 1:11-CVf-00876-RGA, filed Aug. 7, 2014, pp. 1-6.
Exhibit 14, IpLearn's Response Brief in Opposition to Blackboard's Motion for Summary Judgment, C.A. No. 1:11-CVf-00876-RGA, filed Aug. 7, 2014, pp. 1-17.
Blackboard, Inc.'s, Supplemental Exhibits 23 through 29 to IpLearn's Response Brief, C.A. No. 1:11-CV-00876-RGA, filed Aug. 7, 2014, pp. 1.
Exhibit 27, IpLearn's Response Brief in Opposition to Blackboard's Motion for Summary Judgment, C.A. No. 1:11-CVf-00876-RGA, filed Aug. 7, 2014, pp. 1-31.
Blackboard Inc.'s Reply Brief in Further Support of Its Motion for Summary Judgment, C.A. No. 1:11-CV-00876-RGA, filed Aug. 21, 2014, pp. 1-23.
1pLearn's Reply in Support of Its Motion for Summary Judgment, C.A. No. 1:11-CV-00876- RGA, filed Aug. 21, 2014, pp. 1-20.
IpLearn, LLC, v. *Kenexa Corporation et al*, *IpLearn, LLC,* v. *Blackboard, Inc.*, *IpLearn, LLC,* v. *K12, Inc.*, Memorandum Opinion, C.A. No. 1:11-CV-00876-RGA, filed Oct. 22, 2013, pp. 1-16.
IpLearn, LLC, v. *Kenexa Corporation et al*, *IpLearn, LLC,* v. *Blackboard, Inc.*, *IpLearn, LLC,* v. *K12, Inc.*, Memorandum Opinion, C.A. No. 1:11-CV-00876-RGA, filed Feb. 10, 2014, pp. 1-18.
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IpLearn, LLC, v. *Blackboard, Inc.*, *IpLearn, LLC,* v. *K12, Inc.*, Memorandum Order, C.A. No. 1:11-CV-00876-RGA, filed Aug. 26, 2014, pp. 1-3.
Blackboard Inc.'s Answering Brief in Opposition to 1pLearn, LLC's Motion for Summary Judgment, C.A. No. 11-876 (RGA), filed Jul. 31, 2014, pp. 1-31.

* cited by examiner

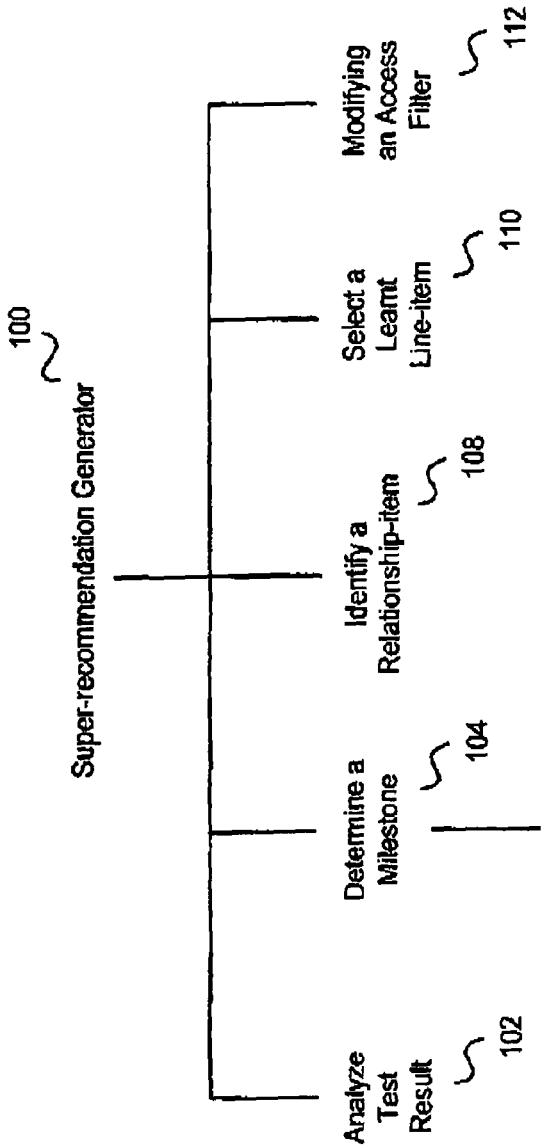
100
Super-recommendation Generator
Analyze Test Result
102
Determine a Milestone
104
Determine a Reward
106
Identify a Relationship-item
108
Select a Learnt Line-item
110
Modifying an Access Filter
112

Figure 1

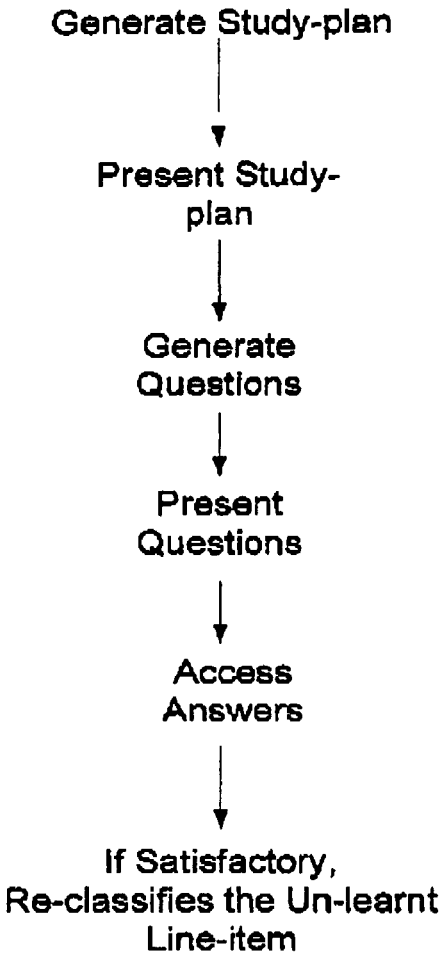
Generate Study-plan
Present Study-plan
Generate Questions
Present Questions
Access Answers
If Satisfactory, Re-classifies the Un-learnt Line-item

Figure 2

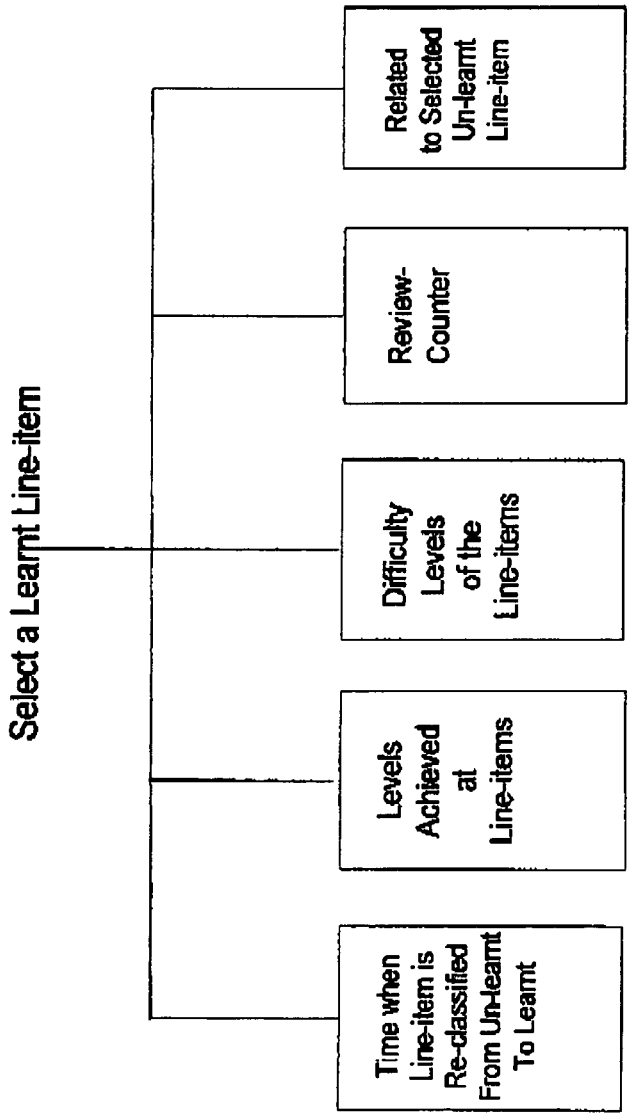
Select a Learnt Line-item
Related to Selected Un-learnt Line-item
Review-Counter
Difficulty Levels of the Line-items
Levels Achieved at Line-items
Time when Line-item is Re-classified From Un-learnt To Learnt

Figure 3

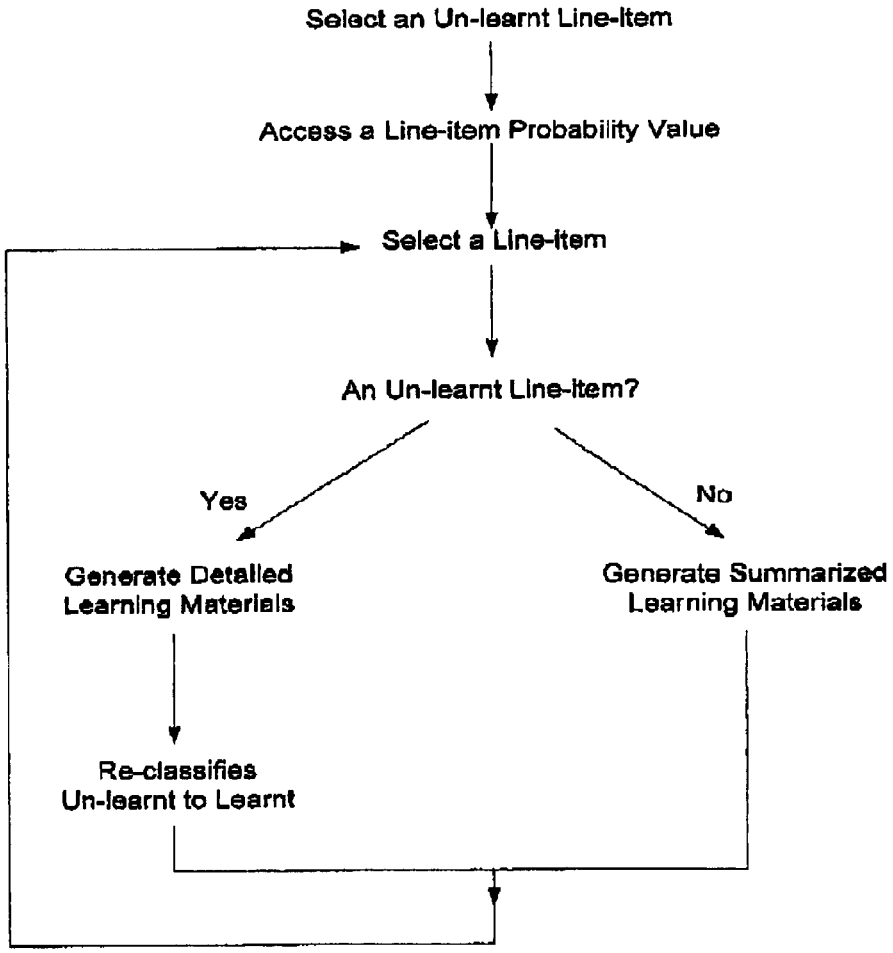
Select an Un-learnt Line-Item
Access a Line-item Probability Value
Select a Line-Item
An Un-learnt Line-Item?
Yes
No
Generate Detailed Learning Materials
Generate Summarized Learning Materials
Re-classifies Un-learnt to Learnt

Figure 4

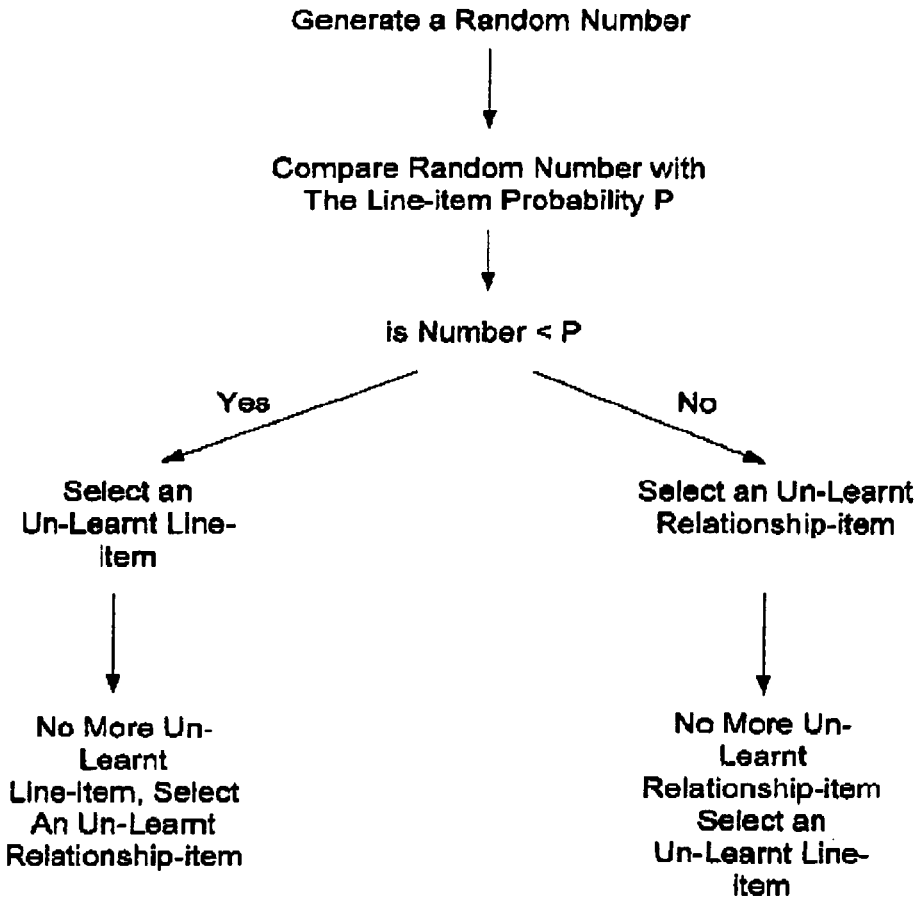
Generate a Random Number
Compare Random Number with The Line-item Probability P
is Number < P
Yes
No
Select an Un-Learnt Line-item
Select an Un-Learnt Relationship-item
No More Un-Learnt Line-Item, Select An Un-Learnt Relationship-item
No More Un-Learnt Relationship-item Select an Un-Learnt Line-item

Figure 5

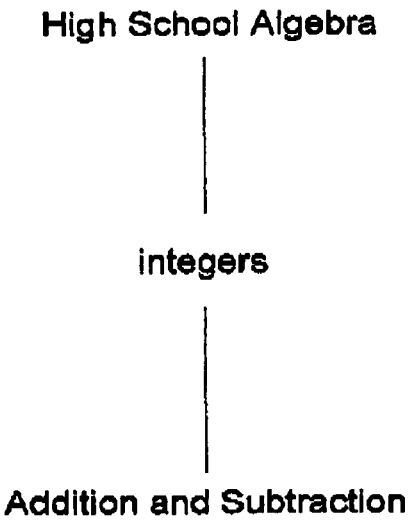

Figure 6

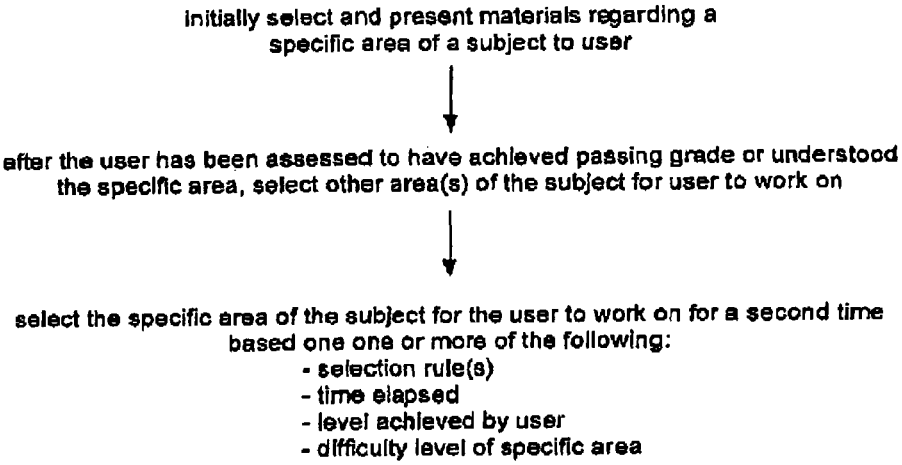
initially select and present materials regarding a specific area of a subject to user
after the user has been assessed to have achieved passing grade or understood the specific area, select other area(s) of the subject for user to work on
select the specific area of the subject for the user to work on for a second time based one one or more of the following:
- selection rule(s)
- time elapsed
- level achieved by user
- difficulty level of specific area

Figure 7

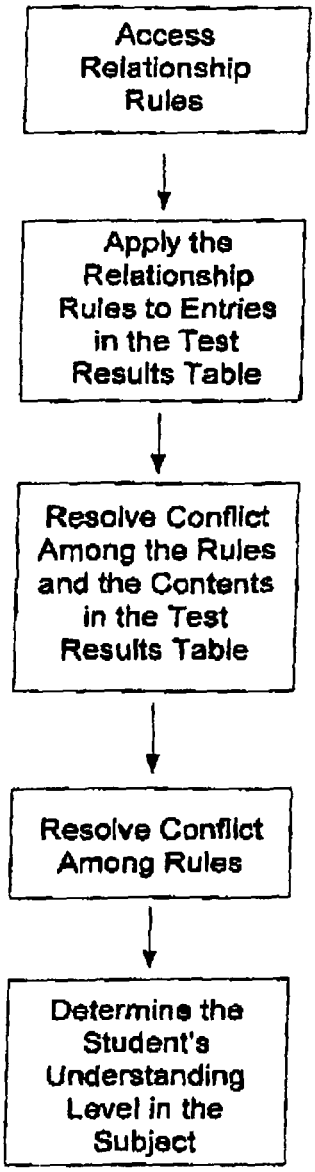
Access Relationship Rules
Apply the Relationship Rules to Entries in the Test Results Table
Resolve Conflict Among the Rules and the Contents in the Test Results Table
Resolve Conflict Among Rules
Determine the Student's Understanding Level in the Subject

Fig. 8

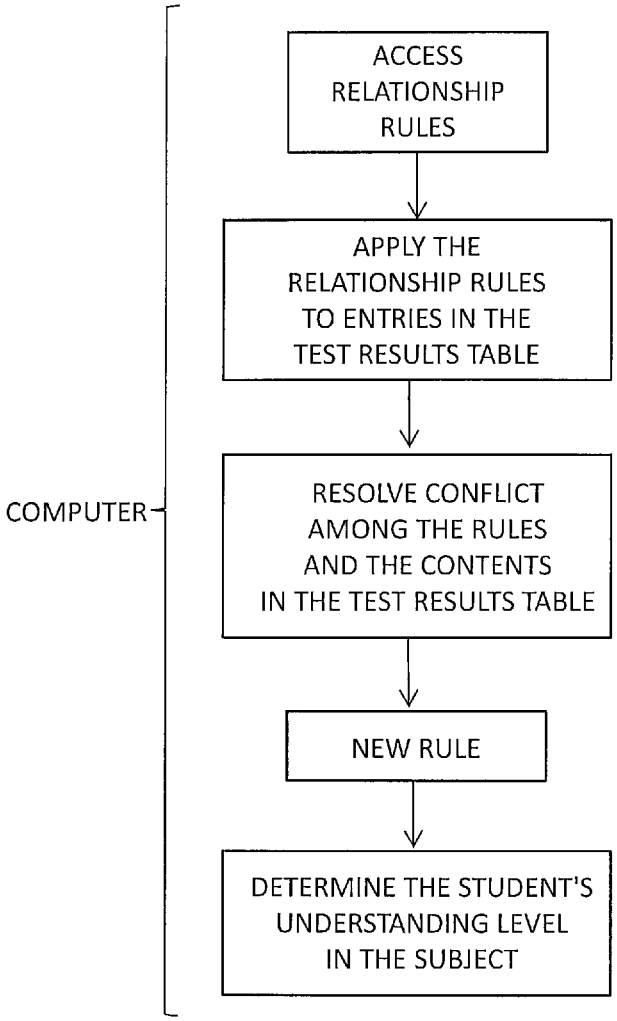
ACCESS RELATIONSHIP RULES
APPLY THE RELATIONSHIP RULES TO ENTRIES IN THE TEST RESULTS TABLE
RESOLVE CONFLICT AMONG THE RULES AND THE CONTENTS IN THE TEST RESULTS TABLE
NEW RULE
DETERMINE THE STUDENT'S UNDERSTANDING LEVEL IN THE SUBJECT
COMPUTER

FIG. 9

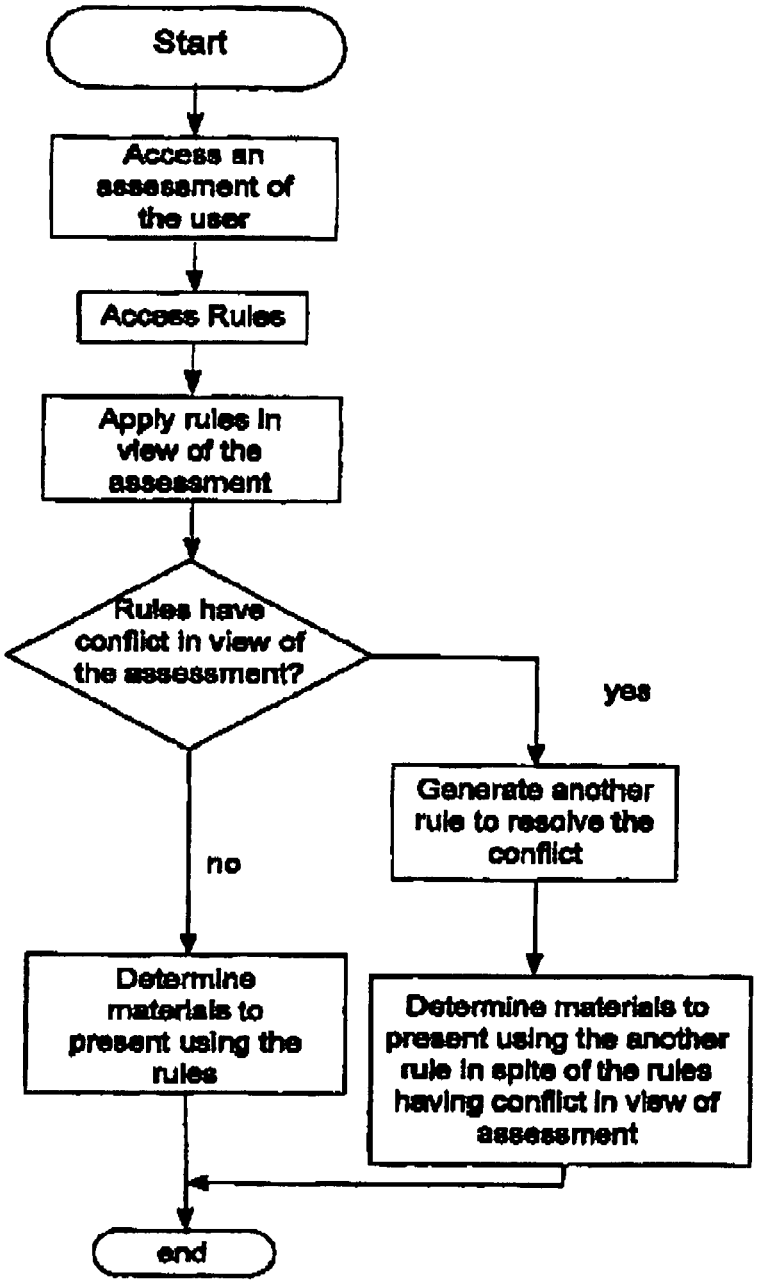
Start
Access an assessment of the user
Access Rules
Apply rules in view of the assessment
Rules have conflict in view of the assessment?
yes
no
Generate another rule to resolve the conflict
Determine materials to present using the rules
Determine materials to present using the another rule in spite of the rules having conflict in view of assessment
end

Figure 10

COMPUTER-AIDED LEARNING SYSTEM AND METHOD

CROSS-REFERENCE TO RELATED APPLICATIONS

This is a continuation of U.S. Pat. No. 6,688,888, issued on Feb. 10, 2004, which is a continuation of U.S. Pat. No. 6,139,330, issued on Oct. 31, 2000, which is a continuation-in-part application of the following patent:

Ser. No. 08/618,193, filed on Mar. 19, 1996, U.S. Pat. No. 5,779,486, entitled, Methods and apparatus to assess and enhance a student's understanding in a subject (the "Test Application");

Ser. No. 08/633,582, filed on Apr. 17, 1996, U.S. Pat. No. 5,743,746, entitled, Reward enhanced learning system and method (the "Reward Application"):

Ser. No. 08/664,023, filed on May 28, 1996, entitled, U.S. Pat. No. 5,727,951, Relationship-based computer-aided-educational system (the "Relationship Application");

Ser. No. 08/675,391, filed on Jul. 2, 1996, U.S. Pat. No. 5,863,208, entitled, Learning system and method based on review (the "Review Application"); and

Ser. No. 08/707,189, filed on Sept. 3, 1996, U.S. Pat. No. 5,743,743, entitled, Learning method and system that restricts entertainment (the "Restrict Application").

All of the above allowed applications and patents are incorporated by reference into this specification.

BACKGROUND OF THE INVENTION

The present invention relates generally to learning and more particularly to using a computer to enhance learning.

The foundation of a vibrant society depends on skilled workers. To strengthen this foundation, every year the U.S. Government with the private industry have poured billions and billions of dollars to improve on learning systems and methods. Money has been spent in areas such as laboratory facilities, educational materials, teacher recruitment and retention, and others. However, for decades, the way to test a student has remained the same; learning has been treated typically as a reward in itself; a fixed syllabus usually controls the educational process of a subject without taking into account students' individual progress; what students have learnt are rarely selectively reviewed; and typically, the students can access non-educational materials when they should be using computers to learn.

It should be obvious that we need methods and systems that are based on computers to remedy the above deficiencies.

SUMMARY OF THE INVENTION

In one embodiment, the present invention provides a learning method and system that assess and enhance a student's or a user's understanding in a subject. Based on the user's understanding, individually-tailored tests are generated, whose difficulties can be geared towards the user's level of understanding in the subject. The user not only can use the tests to prepare for an examination, but can also use the tests to learn the subject.

In another embodiment, the invented method and system are based on the latest test results from the latest test taken by the user on the subject, which can be divided into line-items. Each line-item covers one area in the subject. In yet another embodiment, at least one line-item is more difficult than another line-item. The latest test includes questions from different line-items.

In one embodiment, the invented system includes a score generator coupled to a recommendation generator. In one embodiment, the recommendation generator includes an inference engine; and in another embodiment, the recommendation generator includes a pre-requisite analyzer. The recommendation generator can be coupled to a report generator and a question generator.

In one embodiment, the score generator accesses the user's latest test result and his prior-to-the-latest test results from a storage medium to generate an overall score for each set of questions related to the same line-item. In one embodiment, the prior-to-the-latest test results are test results from the test immediately before the latest test. In another embodiment, each overall score reflects the user's degree of forgetfulness as a function of time for that group of questions. Based on the calculated overall scores, the score generator updates information in the storage medium to include the latest test results.

Both the pre-requisite analyzer and the inference engine in the recommendation generator can generate recommendations based on the user's test results. The pre-requisite analyzer accesses pre-requisite rules, which, based on the complexity levels of the line items, determines a complexity-hierarchy among the line-items. Then, applying the complexity-hierarchy to the test results, the pre-requisite analyzer determines the user's level of understanding in the subject to provide recommendations for the user which, for example, can be providing suggestions to the user as to the line-item to work on.

The inference engine accesses a set of relationship rules that define relationship among the line items and the subject. Then applying the set of relationship rules to the user's test results, the inference engine determines the user's level of understanding in the subject to provide recommendations for the user.

If there is any conflict among one or more relationship rules with the contents in the test results, or if there is any conflict among two or more relationship rules, the inference engine can resolve it. Resolving such conflicts helps to ensure a consistent assessment of the user's understanding in the subject.

In one embodiment, as shown in FIG. **8**, the inference engine can resolve relationship rules that are in conflict, or are not fully consistent. For example,

Rule 1: If a student is weak in algebra, then the student is weak in geometry.

Rule 2: If a student is weak in geometry, then the student is weak in trigonometry.

The inference engine, based on rules 1 and 2, derives Rule 3:

Rule 3: If a student is weak in algebra, the student must be weak in trigonometry. Conversely, if a student is strong in trigonometry, the student must be strong in algebra.

Rule 4: A student strong in trigonometry may not be strong in algebra. The derived rule 3 is in conflict with rule 4. Then, the inference engine derives and adds the following rule as one of the relationship rules:

Rule 5: If a student is strong in trigonometry, but there is no data, latest or prior-to-the-latest, to show the student's ability in algebra, the student should work on algebra next. In the future, this new rule takes precedence over the conflicting rules. With rule 5 applied before rules 1 and 2, rule 3 will not be derived.

Another way to resolve the conflict is to reshuffle the order of application of the rules. For the above example, one way to resolve the conflict between rule 4 and rule 3 is to apply rule 4 before applying rules 1 and 2.

In another embodiment, the inference engine can resolve one or more relationship rules in conflict with the contents in a test results table, such as overall scores. In one embodiment, rules in conflict are disabled. For example with the above rule 1 to rule 3 still active:

The student's overall scores indicate that the student is strong in trigonometry, but weak in algebra. Such scares are in conflict with rule 3, Under such a situation, the inference engine would disable rule 1 for this student. Without rule 1, the engine will not be able to derive rule 3, and they will be no rules in conflict with the overall scores.

Reshuffling the rules, such as rules 1, 2 and 4 above, can also resolve the conflict among the rules and the contents in the test results table, such as the overall scores.

Another way to resolve conflicts is to associate a credit with each rule. The credit is advanced by a certain amount if its corresponding rule is used to generate a recommendation. However, the credit of a rule is decremented by another amount if the rule is found to be in conflict with another rule or with the contents in the test results table. In one embodiment, the increment and the decrement amount are the same. In another embodiment, either the increment or the decrement amount is zero. The order of application of rules is based on the credits of the rules—a rule with a larger credit is applied before a rule with a smaller credit.

Yet another approach to resolve a conflict with the contents in the test results table is to add a new rule, which has precedence over non-new rules. Based on the above example, to prevent conflict with rules 1-3, the following new rule is added;

If a student is strong in trigonometry, but weak in algebra, the student should work on algebra,

In one embodiment, the report generator accesses a report format. Based on the recommendations and the report format, the report generator generates a report, which can provide assessment of the user's understanding in line-items of the latest test and the prior-to-the-latest tests, and which can provide action items to improve on the user's understanding in the subject.

The question generator, based on the recommendations, generates a number of questions, which, in another embodiment, can be categorized into at least two line items—one being the one suggested by the recommendations, and the other being different from the one suggested by the recommendations. The user can take this new set of questions to further enhance his understanding in the subject.

In one embodiment, the invented system and method enhance a user's understanding in a subject through associating the subject's different areas that the user has studied.

The subject can be divided into line-items and relationship-items. Each relationship-item covers areas that relate two or more items. The items include learnt and un-learnt items, with a learnt item being an item that the user has achieved a preset level of learning, and with an un-learnt item being an item that the user has not yet achieved a preset level of learning.

In one embodiment, the recommendation generator also selects and classifies the items. That embodiment includes a learning-material generator for generating learning materials for the user.

In one embodiment of the invented method, first, the recommendation generator selects one un-learnt item. After the selection, the learning-material generator generates learning materials for the user to learn the selected item, and the system assesses the user's learning prowess in the selected item. If the assessment on the selected un-learnt item is satisfactory, then the recommendation generator classifies one or more relationship-items to be learnt as un-learnt items, with each classified relationship-item relating the selected item with one or more learnt items. The recommendation generator can also re-classify the selected item as a learnt item. Then, another un-learnt item can be selected, which can be a line-item, or a relationship-item, The process can continue on until all of the items have been learnt. At that point, the user has mastered the subject.

There are different ways for the recommendation generator to select an un-learnt item. In one embodiment, the recommendation generator selects an un-learnt line-item or an un-learnt relationship-item, depending on a value set by an instructor. If the un-learnt item is a line-item, the process to select a line-item can be based on the difficulty level of the line-item; if the un-learnt item is a relationship-item, the selection process can be based on the difficulty level of the relationship-item, the time the relationship-item was classified as an un-learnt item, and/or whether the user has previously failed to learn the relationship-item.

For the learning materials, in one embodiment, the learning material is includes questions. In another embodiment, the learning material does not include questions.

One embodiment of the invented system and method provide users dynamic reviews. After a user has learnt certain areas in a subject, summarized learning materials on those areas can be selectively generated for the user so as to reinforce the user's learning in the subject through reviews. Unlike prior systems, the reviews in the present invention can be dynamic; they can be specifically tailored to the needs of individual users, or the characteristics of the subject.

In one embodiment, the present invention selects an un-learnt item, and generates detailed learning materials for it. Then a learnt item is selected, for example, based on one or more learnt-item-selection rules, depending on factors such as the time elapsed from the time when the user learnt that item, the level achieved by the user in learning that item, its difficulty level, whether that learnt item is related to the selected un-learnt item, and whether that learnt item has been selected before. Then, the invention generates summarized-learning materials on the selected learnt item for the user to review.

Different materials are applicable for learning. For example, the summarized-learning materials may or may not include questions.

For an un-learnt item, after presenting the generated learning material to the user, the present invention can assess the user's understanding in the item. If the assessment is satisfactory, the un-learnt item can be re-classified as a learnt item.

In another embodiment, the present invention accesses an item probability value to select an item. If the item is an un-learnt item, the invention can generate detailed learning materials for the user; and if the user is successful in learning the materials, the invention can re-classify the item as a learnt item. If the item is a learnt item, the invention can generate summarized learning materials for the user. The invention then can repeat and select another item.

In one embodiment, the present invention enriches a user's learning process through individualizing rewards. The invention allows an instructor or a user to set when and what to reward. The invention also allows a user or the user to delay receiving the reward.

In one embodiment, the invented system teaches the user a subject. The subject is divided into line-items, with at least one line-item being more difficult than another line-item. The instructor, such as the user's teacher, guardian or parent, enters his password into the invented system. If the password matches the instructor's password stored in the system, the instructor has gained access into the system, and can set each

line-item where there should be a milestone. The system also can provide a list of pre-selected rewards for the instructor to pick the reward at each milestone. The list or a part of the list can depend on the user's preference. The system can then generate a milestone/reward table, capturing the instructor's inputs.

In one embodiment, the recommendation generator accesses the table, and determines if the user has reached any one of the milestones set by the instructor. This determination process can be accomplished in a number of ways; for example, it can be done through one or more rules pre-stored in the system. Such information can then be transmitted to a reward determinator.

The reward determinator based on the information in the reward table can determine the type of reward for the user who has reached a milestone. In one embodiment, there are two types of rewards. The first type is a point system, and the second type is an actual reward. The user can accumulate points or get an actual reward. It would be up to the user to decide. If the user's preference is to pick an actual reward, the user can postpone receiving the reward. If the user's preference is to pick the point system, his points can be accumulated as he gets more points through reaching more milestones.

In one embodiment, the report generator accesses the user's preference and the milestone reached by the user from the reward determinator. The generator stores the milestone-reached in the storage medium, and accesses from the storage medium the history of the milestones reached by the user. In one embodiment, based on the accessed information, a report is generated every time the user reaches a milestone. In another embodiment, the instructor can query the report generator to find out about the user's performance. Based on the report, if the user picks points as rewards, then based on the accumulated points, rewards can be set by the instructor accordingly.

If the user does not want to postpone getting the reward, a reward generator generates the reward for the user. Depending on the type of reward, in one embodiment, the reward generator accesses the reward from a reward storage medium; and in another embodiment, the reward generator accesses the reward from a network.

After the user has claimed the reward, the system can ask for the user's feedback as to his interest in the reward. This information is also sent to the report generator to be presented in the report so that the instructor knows whether she should adjust the rewards for future milestones.

If the user has postponed receiving his reward and later decides to re-claim it, he can enter his password into the system. If the password matches the user's password stored in the system, the user can re-claim his postponed rewards.

In one embodiment, the invention provides rewards when the user has demonstrated understanding in the subject through tests, not just when the system has presented instructional materials. That embodiment requires feedback from the user, with rewards reflecting on the user's understanding

In one embodiment, the invented method and system help a user focus on study materials by restricting him from freely enjoying entertainment materials on the computer. With such an invention, the user is not distracted by entertainment materials on the computer when he should be working on the study materials. Even if he wants to play, he has to finish studying first.

In one embodiment, the entertainment materials are presented through an entertainment program, and the study materials are presented through a study program.

In one embodiment, the invented system includes an access filter between the programs and a device. The entertainment program needs the device to entertain. A controller controls the access filter to automatically restrict the coupling between the device and the entertainment program, but simultaneously allow the coupling between the device and the study program.

Different entertainment materials typically require different types of devices to entertain. Some examples of devices required by entertainment materials include speakers, a position-pointing device such as a joy-stick, an output device, a storage medium and a circuit board. The circuit board can be used to couple to video-signals, audio-signals or other digital or analog signals. The video-signals can be television signals.

In one embodiment, the access filter includes a device driver.

Under a predetermined condition, the controller removes the restriction automatically to allow the device to couple to the entertainment program. This can be done through a token system. Under the predetermined condition, the user is given a token, which the user can use to remove the restriction. With the restriction removed, the user can enjoy the entertainment materials.

These predetermined condition can be based on one or more factors, such as the amount of time the user has been working on the study materials, the user's performance in the study materials, and the time of day. In one embodiment, one predetermined condition is a user has claimed a corresponding reward.

Other aspects and advantages of the present invention will become apparent from the following detailed description, which, when taken in conjunction with the accompanying drawings, illustrates by way of example the principles of the invention.

BRIEF DESCRIPTION OF THE DRAWING

FIG. **1** illustrates one embodiment of the present invention.

FIG. **2** shows a process to generate a detailed learning material according to an embodiment in the present invention.

FIG. **3** shows a number of criteria to select a learnt line-item according to different embodiments in the present invention.

FIG. **4** shows a process to implement another embodiment of the present invention.

FIG. **5** shows a process to select an un-learnt line-element or a relationship-item according to an embodiment in the present invention.

FIG. **6** shows different areas of a subject according to an embodiment in the present invention.

FIG. **7** shows another embodiment of the present invention.

FIG. **8** shows another embodiment of the present invention.

FIG. **9** shows another embodiment of the present invention.

FIG. **10** shows another embodiment of the present invention.

However, those skilled in the art will readily appreciate that the detailed description given herein with respect to the figures is for explanatory purposes as the invention extends beyond these limited embodiments.

DETAILED DESCRIPTION OF THE INVENTION

FIG. **1** shows one embodiment of the invention including a super-recommendation generator **100** for implementing a computer-aided learning method to help a student or a user learn a subject. The generator **100** in general is for enhancing the learning experience of the user, and can be implemented in software, firmware, hardware or some combination of the above.

In one embodiment, the subject can be divided into items, including one or more relationship-items, with each relationship-item relating two or more items. The items can include learnt and un-learnt items, with a learnt item being an item that the user has achieved a preset level of learning, and with an un-learnt item being an item that the user has not yet achieved a preset level of learning.

In one embodiment, the super-recommendation generator **100** performs a number of functions, including the following:

assessing a user's understanding in a subject as, for example, described in the Test Application;

rewarding the user who has reached one or more milestones in the subject as, for example, described in the Reward Application;

furthering the user's understanding in the subject through relationship learning, as, for example, described in the Relationship Application;

reinforcing the uses understanding in the subject through reviews, as, for example, described in the Review Application; and

restricting the user from enjoying entertainment materials under certain condition, with the entertainment material requiring a device to fulfill its entertainment purpose, as, for example, described in the Restrict Application.

One embodiment of the super-recommendation generator is configured to perform the following operations:

analyzing (**102**) the user's prior-to-the-latest and the latest test results to assess the user's understanding in the subject, as, for example, described in the Test Application;

determining (**104**) whether the user has reached a milestone, as, for example, described in the Reward Application;

determining a reward (**106**) for the user that has reached a milestone, with the reward depending on the user's preference, as, for example, described in the Reward Application;

identifying (**108**) a relationship-item to be learnt, with the identified relationship-item relating an item and a learnt item, as, for example, described in the Relationship Application;

selecting (**110**) a learnt item to be reviewed, as described, for example, in the Review Application; and

modifying (**112**) an access filter to restrict coupling between the device and the entertainment materials, with the restriction removed to allow coupling between the device and the entertainment materials under a predetermined condition.

In another embodiment, the super-recommendation generator is configured to perform only some of the operations, with the subject categorized accordingly. For example, the generator **100** is configured not to perform the function of modifying an access filter. In another example, the generator **100** is configured to assess (**102**), identify a relationship-item (**108**) and reinforce through reviews (**110**). In yet another example, the generator **100** is configured to perform similar functions as the previous example, except for the function of assessment, in which the generator **100** analyzes the user's test results using a set of analysis rules to determine the user's understanding level in the subject. In a further example, the super-recommendation generator is configured to assess (**102**), determine (**104**) if the user has reached a milestone, and determine (**106**) a reward; for this example, the subject can be categorized to include one or more milestone.

In one embodiment, a system implements an embodiment of the present invention preferably in software and hardware. The system includes a server computer and a number of client computers. Each client computer communicates to the server computer through a dedicated communication link, or a computer network.

The client computer typically includes a bus connecting a number of components, such as a processing unit, a main memory, an I/O controller, a peripheral controller, a graphics adapter and a network interface adapter. The I/O controller is connected to components, such as a hard disk drive. The peripheral controller is connected to components, such as a keyboard. The graphics adapter is connected to a monitor and the network interface adapter is connected to the network. The network includes the internet, an intranet, the world wide web and other forms of networks. Different components of the present invention can be in different elements. And, one or more of the components, such as the recommendation generator, can be implemented on a circuit, such as a field-programmable-gate-array, where the entire program embodying one or more of the components are burnt into the circuit.

In one embodiment, as long as study materials in an area have been presented to a user, it is assumed that the user has mastered the area.

In another embodiment, after presenting to the user study materials in an area, questions are generated and presented to the user. Typical, users gain a better understanding on a subject through actively working on questions, than just through passively reading study materials.

Regarding reinforcing through reviews, in one embodiment, an area is repeated to be learnt depends on the time elapsed from the time when the area was previously learnt. The selection process dis-favors the area that has just been learnt because presumably the area is still fresh in the user's mind. As time passes, the user's memory begins to fade, and should be refreshed. Typically, a user starts to forget what he has learnt a number of weeks, such as three, after he has learnt it. Thus, in one embodiment, the selection process starts favoring reviewing the area that has been learnt three weeks ago.

In another embodiment, the selection process dis-favors the area that has been learnt long time ago because presumably the user has learnt other more difficult area during the interim period. This is similar to a user learning a subject in a semester. After the end of the semester, the user stops reviewing the subject, and starts studying a more difficult subject. Typically, a semester is about three months or twelve weeks. Thus, in one embodiment, the selection process begins to dis-favor reviewing the area that has been learnt more than twelve weeks ago.

In one embodiment, the above elapsed time dependency in selection is embedded in a rule that is represented by the following equation:

$$\text{Weight } w(t)=k*e^{-at*}(l-e^{-t})^{b}$$

where k, a, and b>0. Here the time t starts counting from the time when the area is learnt. Initially, the weight function w(t) increases as time t increases, peaking with time being equal to 1n ((a+b)/a). From that point onwards, the function decreases as time further increases. The values for a and b are chosen to determine the position of the peak, and the value for k is used to adjust the variance of the function.

The bigger the weight of an area, the better the chance for that area to be selected. As an example, the weight is chosen to peak when t is between three weeks (or 21 days) and twelve weeks (or 84 days), which averages to 53 days. Thus, w(t) peaks around 53 days, implying that;

$$1n((a+b)/a)=53.$$

The above exponential weight function is just an example representing the dependency on time. Other weight functions are also applicable, such as the Chi's Square functions.

In another embodiment, selecting an area that previously has been learnt depends on the mastery level achieved by the

user. The lower the grade or the level system should reinforce the user's weaker areas. Again, this can be represented by a weight function, which depends on the mastery level achieved by the user.

In yet another embodiment, selecting an area that previously has been learnt depends on the characteristics of the area, such as the difficulty level of the area. The more difficult the area, the higher the probability to select that area because it is more likely for the user to be weak in that area, or that area is more significant than other areas. Again, the dependency on difficulty level can be represented by a weight function, which tracks the difficulty level of the area.

For another different embodiment, selecting a previous area that has been learnt depends on whether that area is related to the most recently selected area to learn. This embodiment favors a previous area that is related to the most recently selected area because the user may form the relationship himself through working on both of them.

For example, the most recently selected area just learnt is differentiating exponential functions. Then one previous area to review may be the hyperbolic sine and cosine functions. The idea is for the user to form the relationship himself that differentiating hyperbolic sine is the hyperbolic cosine, and vice versa. Typically, a user enjoys learning a subject and remembers it better if he thinks that he, by himself, has developed some insights in the subject.

In one embodiment, an inference engine generates recommendation for a user. First, the engine accesses a set of relationship rules from an analysis-rule-storage medium. These rules define the relationship among different areas in a subject, such as the relationship among line-items, minor-topics, major-topics and the subject. Then the inference engine applies the relationship rules to entries in a test results table to determine the user's understanding level in the subject. In one embodiment, each relationship rule is of the following format:

(consequence, condition1, condition2, . . .).

If all the conditions are satisfied, the consequence is true. If any one of the conditions is not satisfied, the consequence is false.

These rules can be used in many different ways. One way is an if-then-else statement within a program, such as:

```
If the overall-score of a line-item (such as integer
    addition/subtraction or int +/−) at a specific com-
    plexity level >90 then grade := A

else if overall-score >75 then grade := B

else if overall-score >60 then grade := C

else if overall-score >50 then grade := D

else grade := F.

If the grade of (Int +/−)= A and the grade of (Int *,/)=
    A and

the grade of (Int Factorization)= A and

the grade of (Int common divisor) is better than or
    equal to B

then the grade of Int := A.
```

In the above examples, the symbol ":=" denotes an assignment operator; also a grade is similar to a user's mastery level in that item. In another embodiment, a grade is transformed to a description in terms of mastery level, such as weak or strong in that item.

In one embodiment, the relationship rules also determine a number of factors, such as (1) the grade in each line-item of a minor-topic before one is considered strong in that minor-topic; (2) the grade in each minor-topic of a major-topic before one is considered strong in that major-topic; and (3) the grades in each major-topic of the subject before one is considered strong in that subject. Based on the relationship rules, the inference engine can infer not only how well the user performs in a specific complexity level of a line-item, but also how well the user performs in a minor-topic, or a major-topic, or even the subject itself.

In another embodiment, each relationship rule is represented in a table of attributes with one attribute being the consequence and the others conditions. As an example, for the line-item at the specified difficulty level, the grades or consequence and the conditions at that difficulty level are:

	Condition
Grade/Consequence	
A	Overall score of the line item > 90
B	90 >= Overall score of the line item > 75
C	75 >= Overall score of the line item > 60
D	60 >= Overall score of the line item > 50
F	Overall score of the line item <= 50
Consequence	
G(Int +/−) := A	G(Int +/−) at level 8 = A.
G(Int) := A	G(Int +/−) = A, G(Int *, /) = A, G(Int factorization) = A, G (Int common divisor) is better than or equal to B.

In the above example, the term "G" denotes "the grade of."

In yet another embodiment, the relationship rule is represented by a set of Horn's clauses in a logic programming language, such as prolog. For example,

```
G(Int +/−) is A if Overall-score (Int +/−)>90

G(Int +/−) is B if 90>= Overall-score (Int +/−)>75

G(Int +/−) is C if 75>= Overall-score (Int +/−)>60

G(Int +/−) is D if 60>= Overall-score (Int +/−)>50

G(Int +/−) is F if Overall-score (Int +/−)<=50

G(Int) is A if G(Int +/−) is A

and G(Int *,/) is A

and G(Int factorization) is A

and G(Int Common Division) is better than B.

G(Int) is A if G(Int +/−) is A

and G(Int *,/) is A

and G(Int factorization) is A

and G(Int Common Division) is B.
```

Some examples of relationship rules describing the relationship among different line-items, or minor-topics or major-topics are as follows:

Weak in algebra implies weak in geometry;

Weak in integers implies weak in fraction;

Weak in algebra implies weak in trigonometry; and

Weak in geometry implies weak in analytic geometry.

Typically, relationship rules are based on expert knowledge on general relationship among different areas in a subject. The way to generate the rules to form the relationships should be well known to experts in the subject—the more knowledgeable the expert, the more complete the set of rules.

In the above examples, the inference engine operates on the test results table to generate recommendations. In one embodiment, the engine operates on latest overall-scores and prior-to-the-latest overall scores. For example, one latest overall score indicates that the user is very proficient in fractional +/− without common denominator, and one prior-to-the-latest overall score indicates that the user is very proficient in fractional *,/ with integer. Based on the two overall scores, the inference engine can provide a recommendation that the user should work on fractional *,/ without common denominator.

Note that the present invention does not require the user to take many tests. If the user has not done enough questions, then the inference engine would indicate that she has only reached a certain state, such as passing only a minor-topic, not a major-topic of a subject.

Note that in one embodiment, computer can be defined as a machine that can perform a computable function, which can be defined as a function that can be performed by a Turing machine or its equivalence.

Other embodiments of the invention will be apparent to those skilled in the art from a consideration of this specification or practice of the invention disclosed herein. It is intended that the specification and examples be considered as exemplary only, with the true scope and spirit of the invention being indicated by the following claims.

The invention claimed is:

1. A computer-implemented method for helping a user learn, the method comprising:

(a) presenting, by a display, materials to help the user learn, the display being coupled to a computing device, which comprises a rule storage medium, an assessment table including assessment attributes regarding users, and a recommendation generator;

(b) retrieving, by the recommendation generator from the rule storage medium, at least two rules from a group of rules, with at least one of the rules being related to a subject, to help determine additional materials to present to the user,

wherein each of the two rules includes a consequence and one or more conditions,

wherein if any condition of each of the two rules is not satisfied, the consequence of the corresponding rule is false,

wherein each of the two rules is represented in a table of attributes, with one attribute being the consequence of the rule and with one or more other attributes being the one or more conditions of the rule,

wherein the table of attributes is stored in the rule storage medium, and

wherein in retrieving the at least two rules, the consequence and the one or more conditions of each of the two rules are retrieved from the table of attributes in the rule storage medium;

(c) determining a recommendation, by the recommendation generator, based on at least a rule from the table of attributes in the rule storage medium, for the additional materials to present via the display, after the materials have been presented at (a); and

(d) selecting, by the recommendation generator, at least some of the materials presented at (a) to the user via the display, for a further time to refresh the user's memory of the materials,

wherein (c) includes:

analyzing at least the two rules to determine an inference, wherein the inference includes a consequence and at least one condition;

accessing at least two assessment attributes from the assessment table;

determining the at least two assessment attributes from the assessment table being in conflict with the consequence and the at least one condition of the inference; and

generating a new rule, which is added to the group of rules in the rule storage medium and which takes precedence over the at least two rules, in view of the conflict, to determine the recommendation for the additional materials to present via the display.

2. The computer-implemented method as set forth in claim **1**, wherein at (d) the selecting of at least some of the materials presented at (a) for presentation to the user for the further time occurs after the additional materials determined at (c) have been presented.

3. The computer-implemented method as recited in claim **1**, wherein the method further comprises having at least some of the presented materials transmitted via a network to the display to be presented to the user, and wherein the network includes a private network and/or a public network.

4. The computer-implemented method as recited in claim **1**, wherein the at least some of the materials presented to the user at (a) are selected at (d) for presentation to the user for the further time depending on a time elapsed from when the materials are presented at (a).

5. The computer-implemented method as recited in claim **4**, wherein the at least some of the materials presented to by the user at (a) can be repeatedly selected for presentation to the user, but if the time elapsed is more than a predetermined duration of time, the at least some of the materials presented at (a) are no longer selected.

6. The computer-implemented method as recited in claim **1**, wherein the at least some of the materials presented at (a) can be repeatedly selected for presentation to the user.

7. The computer-implemented method as recited in claim **1**, wherein the additional materials to present be presented to the user at (c), also relate to the subject.

8. An article comprising: a non-transitory computer readable storage medium comprising a plurality of instructions for helping a user learn, the plurality of instructions, if executed by a computing device, result in the computing device:

(a) presenting, by a display, materials to help the user learn, the display being coupled to a computing device, which comprises a rule storage medium, an assessment table including assessment attributes regarding users, and a recommendation generator;

(b) retrieving, from the rule storage medium, at least two rules from a group of rules to help determine additional materials to present to the user,

wherein each of the two rules includes a consequence and one or more conditions,

wherein if any condition of each of the two rules is not satisfied, the consequence of the corresponding rule is false,

wherein each of the two rules is represented in a table of attributes, with one attribute being the consequence of

the rule and with one or more other attributes being the one or more conditions of the rule,

wherein the table of attributes is stored in the rule storage medium, and

wherein in retrieving the at least two rules, the consequence and the one or more conditions of each of the two rules are retrieved from the table of attributes in the rule storage medium;

(c) determining a recommendation, a by the recommendation generator, based on at least a rule from the table of attributes in the rule storage medium, for the additional materials to present to the user, after the materials at (a) have been presented; and

(d) selecting, by the recommendation generator, at least some of the materials presented at (a) to the user via the display, for a further time to refresh the user's memory of the materials,

wherein (c) includes:

analyzing at least the two rules to determine an inference, wherein the inference includes a consequence and at least one condition;

accessing at least two assessment attributes from the assessment table;

determining the at least two assessment attributes from the assessment table being in conflict with the consequence and the at least one condition of the inference; and

generating a new rule, which is added to the group of rules in the rule storage medium and which takes precedence over the at least two rules, in view of the conflict, to determine the recommendation for the additional materials to present via the display.

9. The article comprising a computer readable storage medium as recited in claim **8**, wherein the instructions if executed further result in the at least some of the materials presented at (a) being selected at (d) for presentation to the user for the further time depending on the time elapsed from when the materials are presented user accesses the materials at (a).

10. The article comprising a computer readable storage medium as recited in claim **8**, wherein the instructions if executed further result in the additional materials determined to present at (c), also relating to the subject.

11. A computer-implemented method for helping a user learn, the method comprising:

(a) presenting, by a display, materials to help the user learn, the display being coupled to a computing device, which comprises a rule storage medium, an assessment table including assessment attributes regarding users, and a recommendation generator;

(b) retrieving, by the recommendation generator from the rule storage medium, at least two rules from a group of rules, with at least one of the rules being related to a subject, to help determine additional materials to present to the user,

wherein each of the two rules includes a consequence and one or more conditions,

wherein if any condition of each of the two rules is not satisfied, the consequence of the corresponding rule is false,

wherein each of the two rules is represented in a table of attributes, with one attribute being the consequence of the rule and with one or more other attributes being the one or more conditions of the rule,

wherein the table of attributes is stored in the rule storage medium, and

wherein in retrieving the at least two rules, the consequence and the one or more conditions of each of the two rules are retrieved from the table of attributes in the rule storage medium; and

(c) determining a recommendation, by the recommendation generator, based on at least a rule from the table of attributes in the rule storage medium, for the additional materials to present via the display, after the materials have been presented at (a),

wherein the determining, by the recommendation generator, comprises:

analyzing at least the two rules to determine an inference, wherein the inference includes a consequence and at least one condition;

accessing at least two assessment attributes from the assessment table;

determining the at least two assessment attributes from the assessment table being in conflict with the consequence and the at least one condition of the inference; and

generating a new rule, which is added to the group of rules in the rule storage medium and which takes precedence over the at least two rules, in view of the conflict, to determine the recommendation for the additional materials to present via the display.

12. The computer-implemented method as recited in claim **11**, wherein the additional materials to present to the user at (c), are determined depending on a time elapsed from when the materials are presented at (a).

13. The computer-implemented method as recited in claim **11**, wherein the additional materials to present at (c), also relate to the subject.

14. The computer-implemented method as recited in claim **11**, wherein the method further comprises, subsequent to generating the new rule, determining materials to present to another user based on the group of rules, which includes the new rule.

15. A non-transitory computer readable medium including at least executable computer program code tangibly stored therein for helping a user learn, said computer readable medium comprising:

(a) computer program code for presenting, by a display, materials to help the user learn, the display being coupled to a computing device, which comprises a rule storage medium, an assessment table including assessment attributes regarding users, and a recommendation generator;

(b) computer program code for retrieving, from the rule storage medium, at least two rules from a group of rules, with at least one of the rules being related to the subject, to help determine additional materials to present to the user,

wherein each of the two rules includes a consequence and one or more conditions,

wherein if any condition of each of the two rules is not satisfied, the consequence of the corresponding rule is false,

wherein each of the two rules is represented in a table of attributes, with one attribute being the consequence of the rule and with one or more other attributes being the one or more conditions of the rule,

wherein the table of attributes is stored in the rule storage medium, and

wherein in retrieving the at least two rules, the consequence and the one or more conditions of each of the two rules are retrieved from the table of attributes in the rule storage medium; and

(c) computer program code for determining a recommendation, by the recommendation generator, based on at least a rule from the table of attributes in the rule storage medium, for the additional materials to present via the display, after the materials have been presented at (a), wherein the determining the recommendation comprises:

analyzing at least the two rules to determine an inference, wherein the inference includes a consequence and at least one condition;

accessing at least two assessment attributes from the assessment table;

determining the at least two assessment attributes from the assessment table being in conflict with the consequence and the at least one condition of the inference; and

generating a new rule, which is added to the group of rules in the rule storage medium and which takes precedence over the at least two rules, in view of the conflict, to determine the recommendation for the additional materials to present via the display.

16. The non-transitory computer readable medium as recited in claim **15** further comprising computer program code for determining materials to present to another user based on the group of rules, which includes the new rule, subsequent to generating the new rule.

* * * * *