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[Continued on next page]

(54) Title: ADAPTIVE ELECTRONIC LEARNING SYSTEM AND METHOD

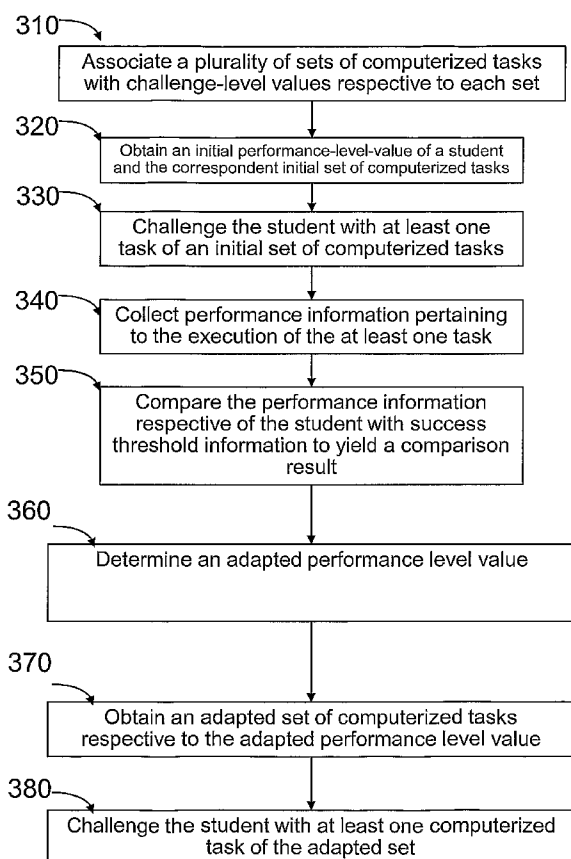


FIG. 3

(57) Abstract: A method of challenging a student may comprise obtaining an initial performance-level-value which may be a specific performance level value respective of, e.g., a specific student; obtaining an initial set of computerized tasks, each task in the initial set has a respective challenge-level-value correlated with the initial performance-level-value; challenging the student with one or more of the computerized tasks being members in the initial set and collecting performance information respective of performance of the student; comparing the performance information with success-threshold-information to yield comparison results; determining an adapted performance-level-value respective of the student in accordance with the initial performance-level-value and the comparison results; obtaining an adapted set of computerized tasks, each task in the adapted set has a respective challenge-level-value corresponding with the adapted performance-level-value; and challenging the student with one or more of the computerized tasks being members in the adapted set.

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# **ADAPTIVE ELECTRONIC LEARNING SYSTEM AND METHOD**

## **5 FIELD OF THE INVENTION**

The present invention concerns the field of electronic learning in general, and methods for adaptive electronic learning in particular.

## **SUMMARY OF THE INVENTION**

10 The present invention discloses a method of challenging a student may comprise obtaining an initial performance-level-value which may be a specific performance level value respective of, e.g., a specific student; obtaining an initial set of computerized tasks, each task in the initial set has a respective challenge-level-value correlated with the initial performance-level-value; challenging the student with one or more of the  
15 computerized tasks being members in the initial set and collecting performance information respective of performance of the student; comparing the performance information with success-threshold-information to yield comparison results; determining an adapted performance-level-value respective of the student in accordance with the initial performance-level-value and the comparison results; obtaining an  
20 adapted set of computerized tasks, each task in the adapted set has a respective challenge-level-value corresponding with the adapted performance-level-value; and challenging the student with one or more of the computerized tasks being members in the adapted set.

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**BRIEF DESCRIPTION OF THE DRAWINGS**

[0001] In order to understand the invention and to see how it may be carried out in practice, embodiments will now be described, by way of non-limiting examples only, with reference to the accompanying drawings, in which:

5 [0002] **Fig. 1** is a schematic block diagram illustration of an adaptive e-learning system, according to some embodiments of the invention;

[0003] **FIG. 2** is a schematic block diagram illustration of a storage unit of the adaptive e-learning system, according to some embodiments of the invention;

[0004] **Fig. 3** is a schematic flow-chart illustration of a method for challenging a  
10 student using the automatically adapted performance-level-values respective of the student, according to some embodiments of the invention; and

[0005] **Fig. 4** is a schematic flow-chart illustration of a method for challenging a student using automatically adapted challenge-level-values respective of a computerized task, according to some embodiments of the invention.

15 [0006] The drawings taken with the description thereof make apparent to those skilled in the art, how the invention may be embodied in practice. Where considered appropriate, reference numerals may be repeated among the figures to indicate identical elements.

20 **DETAILED DESCRIPTION OF EMBODIMENTS OF THE INVENTION**

[0007] The field of electronic learning, which is known as "eLearning", "e-learning" or "elearning", is concerned with challenging students with computerized tasks. The term "student" as used herein refers to an entity challenged with one or more computerized tasks. Such an entity may be interchangeably embodied by a person and a computerized

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module using the computerized system for learning, for example, the usage of certain application. It is noted that learning is not limited to a specific field in the art.

[0008] In accordance with certain embodiments of the invention, a method of challenging a student using automatically adapted performance-level-values respective  
5 of the student, comprises, obtaining an initial performance-level-value, whether a specific performance level value respective of a specific student or a general performance level value respective of a group of students or a general performance level value respective of all students or having a predefined default value; obtaining an initial set of computerized tasks, wherein each task in the initial set has a respective challenge-  
10 level-value that corresponds with the initial performance-level-value; challenging the student with one or more of the computerized tasks being members in the initial set and collecting performance-information respective of execution of the initial set of tasks by the student; comparing the collected performance-information respective of the execution of the initial set of tasks by the student with a success-threshold-information  
15 to yield comparison results; determining an adapted performance-level-value respective of the student in accordance with the initial performance-level-value and the comparison results; obtaining an adapted set of computerized tasks, each task in the adapted set has a respective challenge-level-value correspondent with the adapted performance-level-value; and challenging the student with one or more of the  
20 computerized tasks being members in the adapted set of computerized tasks.

[0009] Further in some other embodiments of the invention, a method of determining an adapted challenge-level-value respective of one or more computerized tasks, may comprise: obtaining an initial challenge-level-value for the computerized task(s); confronting one or more students with the computerized task(s) and collecting collected  
25 performance information respective to the execution of the computerized task(s) by one

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or more of the students; determining a success level respective of the computerized task in accordance with said collected performance information; and updating the challenge-level-value in accordance with the success level.

[0010] According to certain embodiments of the present invention presented below, adaptive e-learning methods and systems are disclosed, that enable challenging of a student, with a plurality of sets of one or more computerized tasks. Each computerized task has associated therewith a challenge-level-value respective to each set, whereby the challenge-level-value may correspond to the degree of difficulty of the computerized task. It should be noted the term "degree of difficulty" as specified herein may be derived experimentally using, for example, statistical methods, as known to those versed in the art. For example, one or more students may be challenged with a plurality of computerized tasks, wherein each student is asked to grade the difficulty of each of the computerized tasks, whereupon the grades respective to each task may be averaged. The obtained average grade respective to each task may correspond to a respective challenge-level-value.

[0011] According to one embodiment of the invention, the student is challenged with at least one computerized task of an initial set, whereby an initial performance-level-value may be associated with the student. It is noted that it is not obligatory, according to the embodiment, to challenge the student with all the tasks being members of the set. Hence, it is possible to challenge the student with one or more of the computerized tasks being members in the initial set. For example, it is possible that the initial set includes several tasks having different challenge level-values, while it is allowed to challenge the student only with those tasks whose challenge-level-values is in a certain range, while not challenging him/her, at this stage, with the other tasks that are not within the said range of challenge-level-values.

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[0012] The information respective of the accomplished performance of the student, who is challenged with one or more of the computerized tasks, at one or more opportunities, is collected by the adaptive e-learning system to constitute "performance information".

[0013] According to certain embodiments, the performance information can include a  
5 set of numbers grading the student's execution of one or more computerized tasks. The performance information is then compared with success-threshold-information to yield comparison results. Such success-threshold-information may represent for example a predefined threshold value representing a requirement pertaining to the successful execution of the one or more computerized task by the student, whereby meeting and/or  
10 exceeding the predefined requirement results in determining an adapted-performance-level-value respective to the same student. The success-threshold-information may, e.g., depend on one or more parameters such as, for example, the minimum number of tasks that have to be executed correctly, or the minimum number of tasks that have to be executed correctly within a predetermined time span. For example, a user of an adaptive  
15 e-learning system operating in accordance with embodiments of the invention may define that 4 tasks being members of the same set of tasks have to be executed correctly by the student within, e.g., 30 seconds, in order to determine an adapted initial performance-level-value respective to the student in accordance with the initial performance-level-value and the comparison result(s). Therefore, if the comparison  
20 between the performance information and the success-threshold-information yields that the execution of the tasks by the student meets the requirements as defined by means of the said success-threshold-information, an adapted performance-level-value respective of the student may be determined. Further, the student is challenged with another set of at least one computerized task associated to one or more given challenge-level-values  
25 that correlate with the adapted performance-level-value. If the execution of the tasks

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meets the requirements as represented by means of the success-level-information, then the one or more adapted challenge-level-values are on the average higher than, e.g., the average or median value of the initial challenge-level-values. Conversely, if the execution of the tasks does not meet the requirements as represented by means of the success-level-information, then the one or more adapted challenge-level-values may be lower than, e.g., the average or median value, of the initial challenge-level-values or the initial challenge level value may remain with no change.

[0014] An example of how to perform a comparison between performance information and the success-threshold-information is provided herein: A student may be defined as having an initial performance-level-value of 60 and may be challenged with a set of 10 computerized tasks having related therewith a success-threshold-information predefined as 1. In the example the student successfully performed 8 computerized tasks, while other students on the average successfully perform only 6 out of the 10 tasks. Thus, the comparison of the said results yields a comparison result of  $8/6=1.33$ . Subsequently an adapted performance-level-value of  $60*1.33=80$  may be determined for the said student. Correspondingly, an adapted challenge-level-value may be determined. It should be noted that the comparison between the performance information and the success-threshold-information may be performed in many other ways. For example, the average number of successfully computerized tasks (e.g., 6) may be subtracted from the number successfully executed tasks (e.g., 8) by the student. The comparison may thusly yield a result of  $8-6=2$ , which may then be multiplied with the initial performance-level-value.

[0015] Reference is now made to **Fig. 1**, which is a schematic block diagram illustration of an adaptive e-learning system, according to some embodiments of the invention. According to some embodiments of the invention, an adaptive learning system **100** may include a computer module **101**, which may comprise a processor **110**, an input unit



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120, an output unit 130 and a storage unit 140, all of which may be operatively linked to a power supply 150.

5 [0016] According to some embodiments of the invention, storage unit 140 may store therein data representing a plurality of sets of computerized tasks, whereby each computerized task may have corresponding therewith a challenge-level-value.

[0017] More specifically, the computerized tasks may be stored in sets embodying one or more computerized tasks with similar challenge-level-values, determining together  
10 the challenge-level-value of the said set. Each such set may relate to a predefined performance-level-value (not shown). Other sets can be formed using a different method of associating, such as subject, type of task etc.

[0018] It should be noted that in some embodiments of the invention, the performance-level-value is embodied by the challenge-level-value, i.e., it is possible that the  
15 performance-level-value and the challenge-level-value are the same data-entity.

[0019] Fig. 2 is a schematic block diagram illustration of a storage unit of the adaptive e-learning system, according to some embodiments of the invention. For exemplary purposes only, the plurality of sets of computerized tasks is hereinafter referred to as “set 1410”, “set 1420” and “set 1430”, whereby computerized tasks A1, A2 and A3  
20 may constitute set, 1410; computerized task B1, B2, B3 and B4 may constitute set 1420; and computerized task C1 may constitute set 1430. Whereby the computerized tasks constituting sets 1410, 1420 and 1430 may correspond with challenge-level-values 1412, 1422 and 1432, respectively. In the storage unit 140 the challenge-level-values may correspond to determined performance-level-values. For example,  
25 performance-level-values ranging from, e.g., 1 to 33, may correspond with challenge-

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level-value **1412**, performance-level-values ranging from, e.g., 34 to 66 may correspond with challenge-level-value **1422**, and performance-level-values ranging from 67 to 100 may correspond with challenge-level-value **1432**, whereby challenge-level-values 1412, 1422 and 1432 may hold the values 1, 2 and 3, respectively.

5 [0020] Yet, this is non-limiting as in other embodiments of the invention, the same performance-level-value may relate to different sets of computerized tasks and therefore to different challenge-level-values. For example, a performance-level-value representing the value 50 may relate to both sets **1410** and **1420**.

[0021] It is noted that the challenge-level-values and the performance-level-values  
10 brought in the current example are brought by way of example, and other levels and/or scales are allowed as well.

[0022] It should be noted that one or more computerized tasks being members in the initial set may be similar to one or more of the computerized tasks being members in the  
15 adapted set.

[0023] For example computerized tasks **A1**, **A2** and **A3** may constitute the initial set while computerized tasks **B1** and **A1** may constitute the adapted set.

[0024] Storage unit **140** may further include instructions, which, when executed by processor **110** result in an application **160** that, *inter alia*, initially challenges a student  
20 via output unit **120** with a one or more tasks of the same set e.g., set **1410**, having related therewith an initial performance-level-value of, e.g., **2**.

[0025] It should be noted that in some embodiments of the invention, the student may be challenged by default with a specific computerized task being a member of the corresponding set. However, in some other embodiments of the invention, a user of  
25 system **100** may determine which should be the initial set of computerized tasks. Yet

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alternatively a computerized task may automatically determine the initial set of computerized tasks, e.g., by using random or semi-random selection, or in accordance with any relevant criteria or criterion.

[0026] In some embodiments of the invention, system **100** is additionally adapted to  
5 receive or collect from the student via input unit **120** performance information by means of input data representing the execution of the at least one task. Performance information may comprise, for example, the number of computerized tasks correctly executed by the student, the time required by the student to execute the tasks, and the like.

10 [0027] According to certain embodiments, application **160** then compares the performance information with the success-threshold-information yielding a comparison result. Depending on the comparison result, application **160** may retain the initial performance-level-value or determine an adapted performance-level-value and challenge the student with an adapted set of computerized tasks corresponding with the  
15 challenge-level-value that corresponds with the adapted performance-level-value. If for example, the comparison result is, e.g., above a predetermined threshold value, then application **160** may determine a higher performance-level-value to the said student and subsequently challenge the student with an adapted set of computerized tasks. However, in the event that the comparison result is, for example, equal or below the  
20 predetermined threshold value, application **160** may retain the initial performance-level-value or alternatively, determine that the student has a performance-level-value which is lower than the initial performance-level-value.

[0028] It should be noted that as already indicated hereinabove the initial set of computerized tasks with which the student is challenged, may be determined in  
25 accordance with an initial performance-level-value, which was obtained prior to having

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determined the current performance-level-value in response to the at least one computerized task of the initial set.

[0029] The initial performance-level-value may be predetermined, or may be obtained in response to one or more preceding computerized tasks.

5 [0030] Referring now to **FIG. 3**, it illustrates a schematic flow-chart illustration of a method for challenging a student using the automatically adapted performance-level-values respective of the student, according to some embodiments of the invention. The adaptive learning method, or a method for challenging the student may for example include, as indicated by box **310**, the act of associating a plurality of sets of  
10 computerized tasks with challenge-level-values respective to each set.

[0031] According to some embodiments of the invention, the method may for example include, as indicated by box **320**, the act of obtaining an initial performance-level value.

[0032] According to some embodiments of the invention, the method may for example include, as indicated by box **330**, the act of challenging the student with at least one  
15 computerized task of an initial set of tasks, whereby the challenge-level-values of the at least one computerized task is in correlation with the initial performance-level-value.

[0033] According to some embodiments of the invention, the method may for example include, as indicated by box **340**, the act of collecting performance information pertaining to the execution of the at least one computerized task by the student.

20 [0034] According to some embodiments of the invention, the method may for example include, as indicated by box **350**, the act of comparing the performance information respective of the student with the success-threshold-information to yield a comparison result.

[0035] According to some embodiments of the invention, the method may for example  
25 include, as indicated by box **360**, the act of determining an adapted performance-level-

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value. The adapted performance-level-value may be determined according to the comparison result. Further, the adapted performance-level-value may also be determined according to the initial performance-level-value.

[0036] According to some embodiments of the invention, the method may for example  
5 include as indicated by box 370, the act of obtaining an adapted set of computerized tasks respective to the adapted performance-level-value.

[0037] According to some embodiments of the invention, the method may for example include, as indicated by box 380, the act of challenging the student with at least one computerized task of the adapted set.

10 [0038] In accordance with certain embodiments, the present invention also includes a method of determining an adaptive challenge-level-value respective of a computerized task. Each computerized task has associated thereto an initial challenge-level-value, whereby a challenge-level-value may correspond to the degree of difficulty of a computerized task.

15 [0039] Additional reference is now made to **FIG. 4**, which shows a schematic flow-chart illustration of a method for challenging a student using automatically adapted challenge-level-values respective of a computerized task, according to some embodiments of the invention. The adaptive e-learning system and method enable challenging students with the computerized task and collecting collected success level  
20 information determining a success level respective of the computerized task. The success level information collected relates to the success of the students in performing the said computerized task and rates the success level of each student with relation to computerized task. The success level information of all or some of the students with regard to the computerized task is then compared with the success-threshold-  
25 information, to yield comparison results. If for example, the comparison yields that the

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relation between the success level of all students tested and the success-threshold-information, for example information relating to an average of success of average students with regard to an average task, is above a predefined threshold value, (which may mean that the computerized task is too easy for an average student), then the  
5 system and/or method may determine an adapted challenge-level-value respective of the said computerized task. The success-threshold-information may also be an averaged value and/or a median value and/or any other statistical value derived from other success level values respective to a computerized task.

[0040] The adaptive e-learning method, or a method for challenging the student may for  
10 example include, as indicated by box **410**, the act of obtaining an initial challenge-level-value for a computerized task.

According to some embodiments of the invention, the method may for example include, as indicated by box **420**, the act of challenging students with the computerized task and collecting collected success level information respective of the success of the students  
15 in performing the computerized tasks.

[0041] According to some embodiments of the invention, the method may for example include, as indicated by box **430**, the act of determining a success level respective of the computerized task in accordance with said collected success level information.

[0042] According to some embodiments of the invention, the method may for example  
20 include, as indicated by box **440**, the act of updating the challenge-level-value in accordance with the success level.

[0043] It should be understood that an embodiment is an example or implementation of the inventions. The various appearances of "one embodiment," "an embodiment" or "some embodiments" do not necessarily all refer to the same embodiments.

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[0044] Although various features of the invention may be described in the context of a single embodiment, the features may also be provided separately or in any suitable combination. Conversely, although the invention may be described herein in the context of separate embodiments for clarity, the invention may also be implemented in a single  
5 embodiment.

[0045] Reference in the specification to "one embodiment", "an embodiment", "some embodiments" or "other embodiments" means that a particular feature, structure, or characteristic described in connection with the embodiments is included in at least one embodiment, but not necessarily all embodiments, of the inventions.

10 [0046] It should be understood that the phraseology and terminology employed herein is not to be construed as limiting, and is for descriptive purpose only.

[0047] The principles and uses of the teachings of the present invention may be better understood with reference to the accompanying description, figures and examples.

[0048] It should be understood that the details set forth herein do not construe a  
15 limitation to an application of the invention. Furthermore, it should be understood that the invention can be carried out or practiced in various ways and that the invention can be implemented in embodiments other ways than the ones outlined in the description below.

20 [0049] It should be understood that the terms "including", "comprising", "consisting" and grammatical variants thereof do not preclude the addition of one or more components, features, steps, integers or groups thereof and that the terms are not to be construed as specifying components, features, steps or integers.

[0050] If the specification or claims refer to "an additional" element, that does not  
25 preclude there being more than one of the additional element.

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[0051] It should be understood that where the claims or specification refer to "a" or "an" element, such reference is not to be construed as there being only one of that element.

[0052] It should be understood that where the specification states that a component, feature, structure, or characteristic "may", "might", "can" or "could" be included, that  
5 particular component, feature, structure, or characteristic is not required to be included.

[0053] Where applicable, although state diagrams, flow diagrams or both may be used to describe embodiments, the invention is not limited to those diagrams or to the corresponding descriptions. For example, flow need not move through each illustrated box or state, or in exactly the same order as illustrated and described.

10 [0054] The term "method" refers to manners, means, techniques and procedures for accomplishing a given task including, but is not limited to those manners, means, techniques and procedures either known to, or readily developed from known manners, means, techniques and procedures by practitioners of the art to which the invention belongs.

15 [0055] Although some demonstrative embodiments of the invention are not limited in this regard, discussions utilizing terms such as, for example, "processing," "computing," "calculating," "determining," "establishing", "analyzing", "checking", or the like, may refer to operation(s) and/or process(es) of a computer, a computing platform, a computing system, or other electronic computing device, that manipulate and/or  
20 transform data represented as physical (e.g., electronic) quantities within the computer's registers and/or memories into other data similarly represented as physical quantities within the computer's registers and/or memories or other information storage medium that may store instructions to perform operations and/or processes.

[0056] The descriptions, examples, methods and materials presented in the claims and  
25 the specification are not to be construed as limiting but rather as illustrative only.



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[0057] Meanings of technical and scientific terms used herein ought to be commonly understood as by one of ordinary skill in the art to which the invention belongs, unless otherwise defined.

5 [0058] The present invention can be implemented in the testing or practice with methods and materials equivalent or similar to those described herein.

[0059] While the invention has been described with respect to a limited number of embodiments, these should not be construed as limitations on the scope of the invention, but rather as exemplifications of some of the embodiments. Those skilled in the art will  
10 envision other possible variations, modifications, and programs that are also within the scope of the invention. Accordingly, the scope of the invention should not be limited by what has thus far been described, but by the appended claims. Therefore, it should be understood that alternatives, modifications, and variations of the present invention are to be construed as being within the scope of the appended claims.

15 [0060] It should be understood that some embodiments of the invention may be implemented, for example, using a machine-readable medium or article which may store an instruction or a set of instructions that, if executed by a machine, cause the machine to perform a method or operations or both in accordance with embodiments of the invention. Such a machine-readable medium may include, for example, any suitable  
20 processing platform, computing platform, computing device, processing device, computing system, processing system, computer, processor, or the like, and may be implemented by hardware and/or software, and/or firmware and/or hybrid modules. The machine-readable medium or article may include but is not limited to, any suitable type of memory unit, memory device, memory article, memory medium, storage article,  
25 storage unit. storage medium or storage unit such as, for example, memory, removable

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or non-removable media, erasable or non-erasable media, writeable or re-writeable media or non-rewriteable media, digital or analog media, random access memory (RAM), flash memory, read-only-memory (ROM), programmable ROM , Erasable Programmable ROM, Electrically Erasable Programmable ROM, optical disk, hard disk, floppy disk, Compact Disk Recordable (CD-R), Compact Disk Read Only Memory (CD-ROM), Compact Disk Rewriteable (CD-RW), magnetic media, various types of Digital Versatile Disks (DVDs), a rewritable DVD, a tape, a cassette, or the like. The instructions may include any suitable type of code, for example, an executable code, a compiled code, a dynamic code, a static code, interpreted code, a source code or the like, and may be implemented using any suitable high-level, low-level, object-oriented, visual, compiled and/or interpreted programming language and/or programming environment. Such a compiled and/or interpreted programming language and/or environment may be, for example, C, C++, C#, .Net, Java, Pascal, MATLAB, BASIC, Cobol, Fortran, assembly language, machine code and the like.

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## CLAIMS

1. A method of challenging a student using automatically adapted performance-level values respective of the student, the method comprising:
  - obtaining an initial performance-level-value, said initial performance-level-value
  - 5 being a specific performance level value respective of a specific student or a general performance level value respective of a group of students or a general performance level value respective of all students or having a predefined default value;
  - obtaining an initial set of computerized tasks, each task in the initial set has a
  - 10 respective challenge-level-value correlated with the initial performance-level-value;
  - challenging the student with one or more of the computerized tasks being members in the initial set and collecting performance information respective of performance of the student;
  - 15 comparing the performance information with success-threshold-information to yield comparison results;
  - determining an adapted performance-level-value respective of the student in accordance with the initial performance-level-value and the comparison results;
  - obtaining an adapted set of computerized tasks, each task in the adapted set has a
  - 20 respective challenge-level-value corresponding with the adapted performance-level-value; and
  - challenging the student with one or more of the computerized tasks being members in the adapted set .

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2. The method of claim 1, wherein one or more of the computerized tasks being members in the initial set is similar to one or more of the computerized tasks being members in the adapted set.
- 5 3. A method of determining an adaptable challenge-level-value respective of a computerized task, the method comprising:
  - obtaining an initial challenge-level value-for the computerized task;
  - challenging students with the computerized task and collecting collected success level information respective of success of the students in performing the
  - 10 computerized tasks;
  - determining a success level respective of the computerized task in accordance with said collected success level information; and
  - updating the challenge-level-value in accordance with the success level.

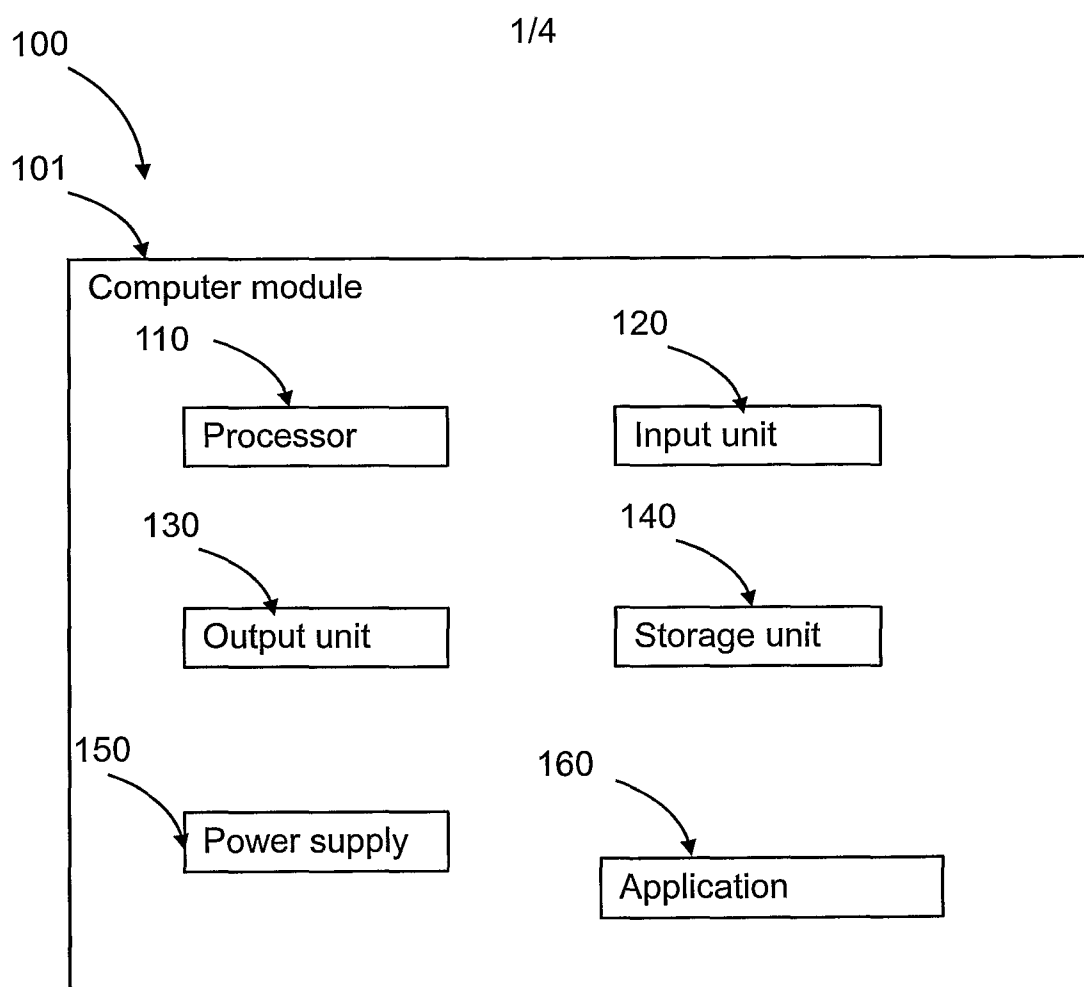


FIG. 1

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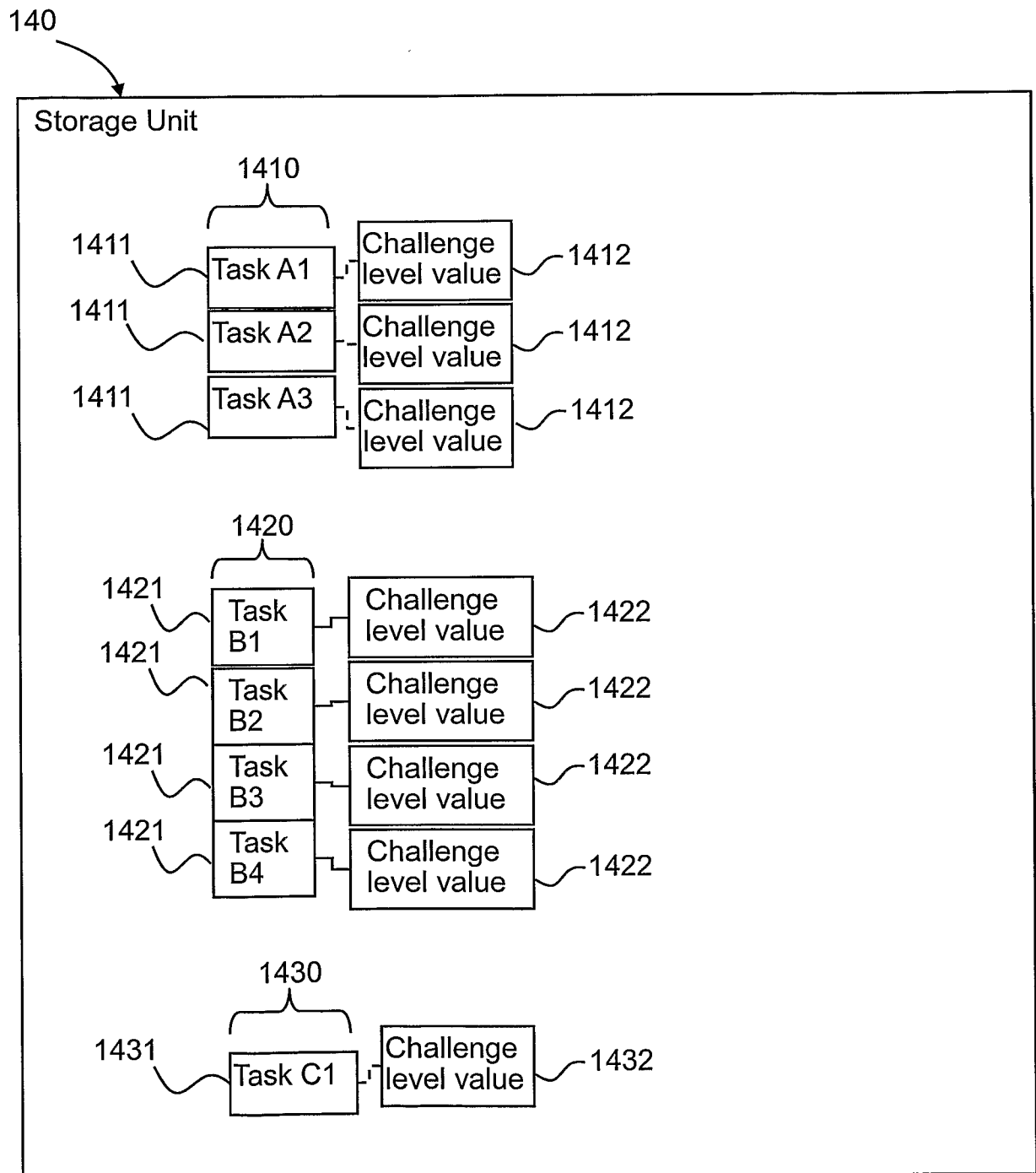


FIG. 2

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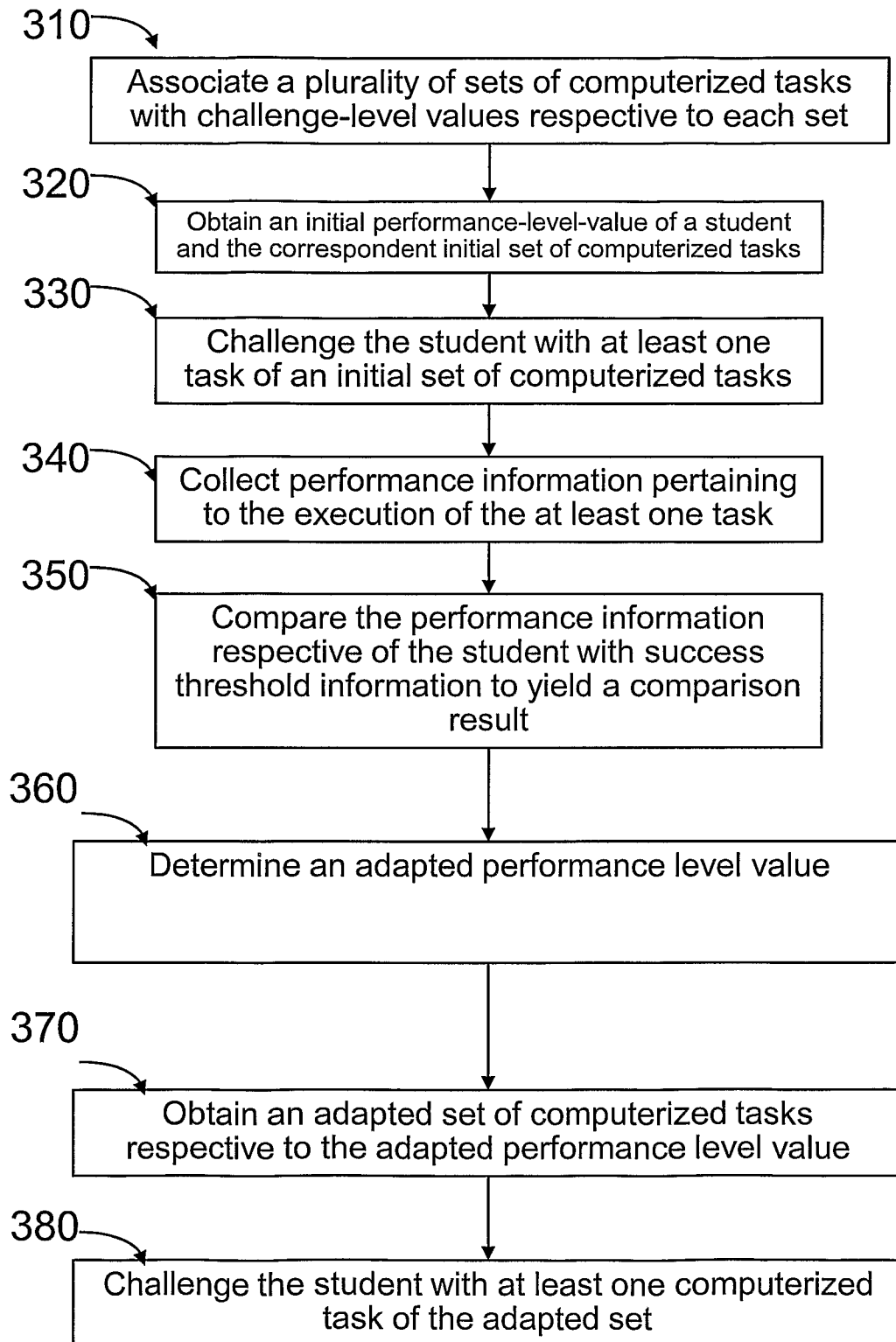


FIG. 3

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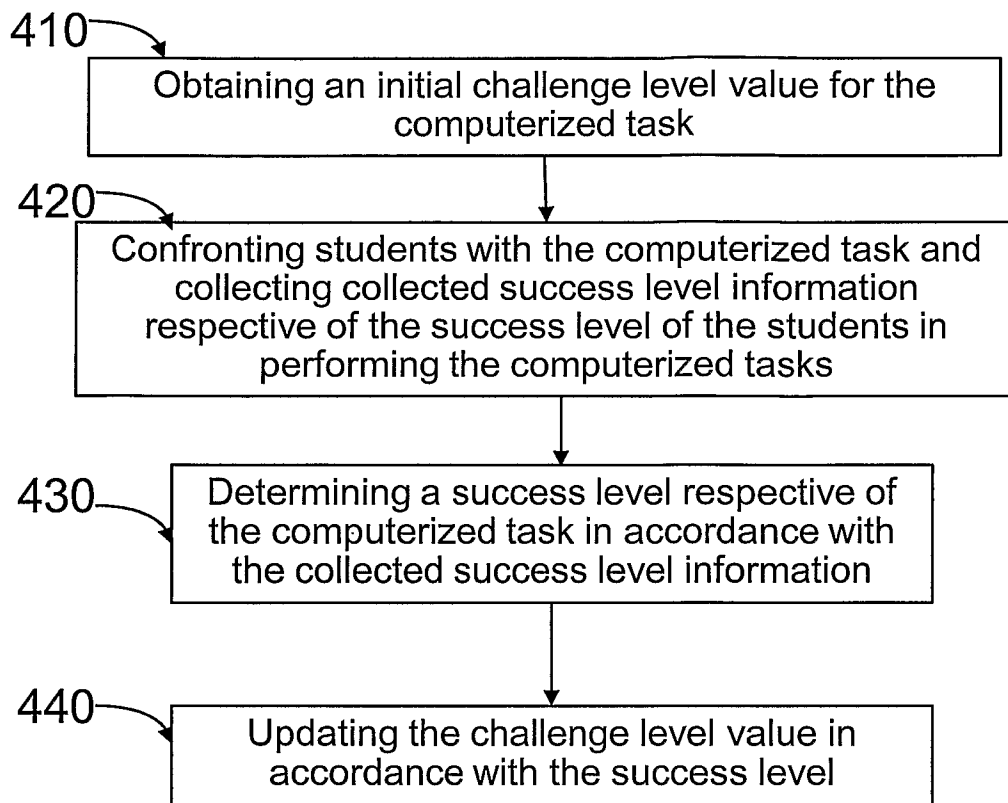


FIG. 4