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(54) **ELECTRONIC LEARNING SYSTEM**

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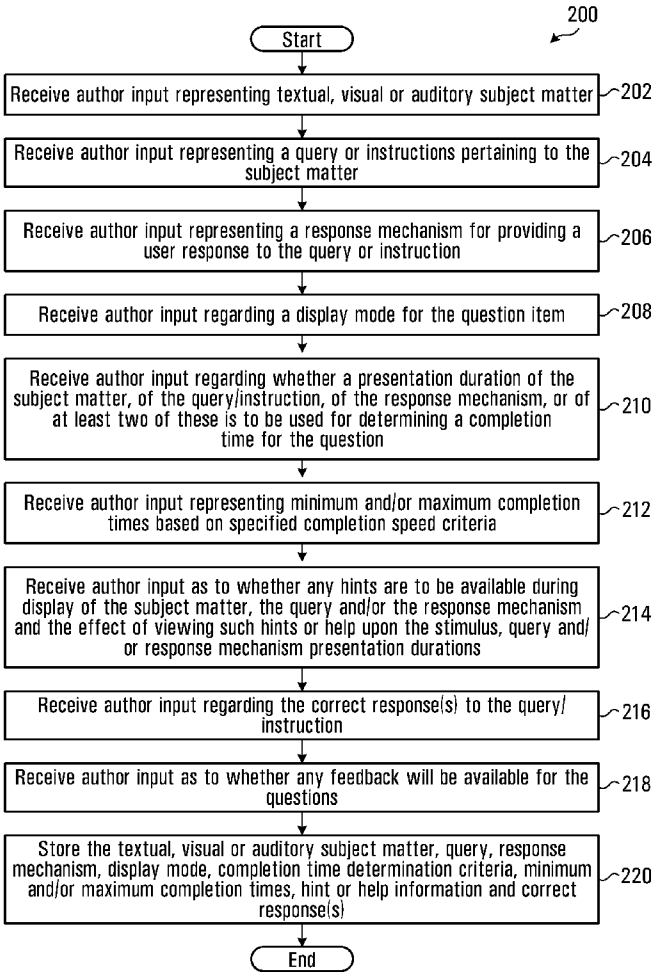
USPC **434/353**; 434/362

(57) **ABSTRACT**

A question item comprising: textual, visual or auditory subject matter; a query or instruction pertaining to the subject matter; and a representation of a response mechanism for receiving a user response to the query or instruction, may be retrieved from a data store. The subject matter, query or instruction and response mechanism may be presented in a presentation sequence, wherein a presentation duration of each of the subject matter, query or instruction and response mechanism is controlled by user input. Based on the user input, a presentation duration of each of the subject matter, query or instruction, and response mechanism may be determined. Each of the three presentation durations may be stored. A completion time may be determined based on one or more of the presentation durations and may be stored along with response accuracy, for use in calculating a user competency measure for the question item. An algorithm for advancing through an electronic learning curriculum comprising multiple question items may also be provided.



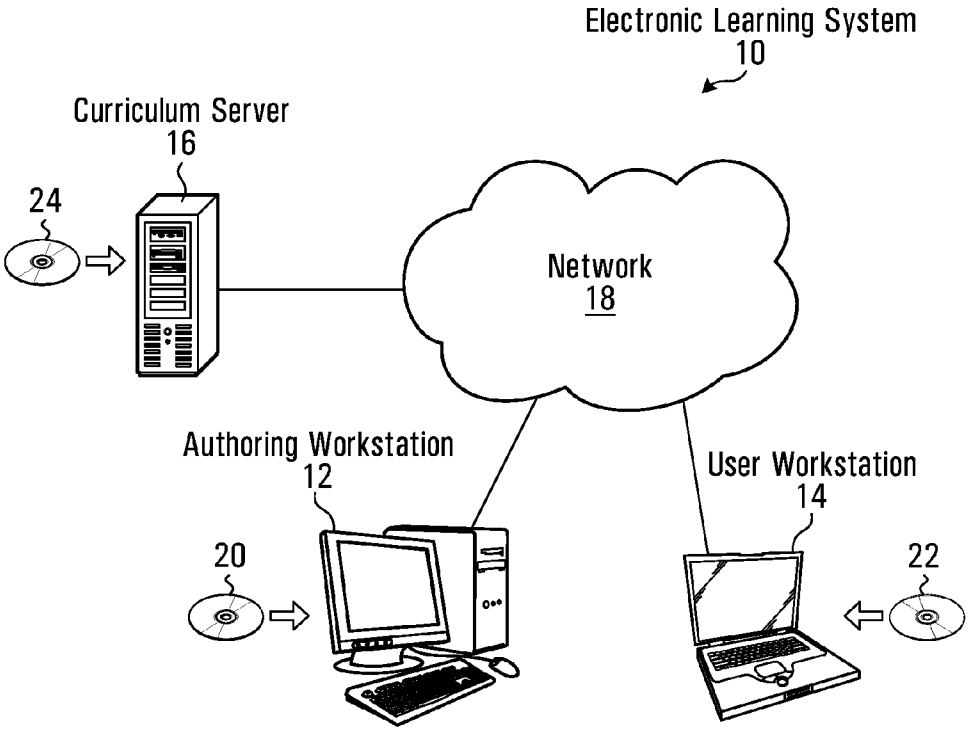

Electronic Learning System
10
Curriculum Server
16
24
Network
18
Authoring Workstation
12
User Workstation
14
20
22

FIG. 1

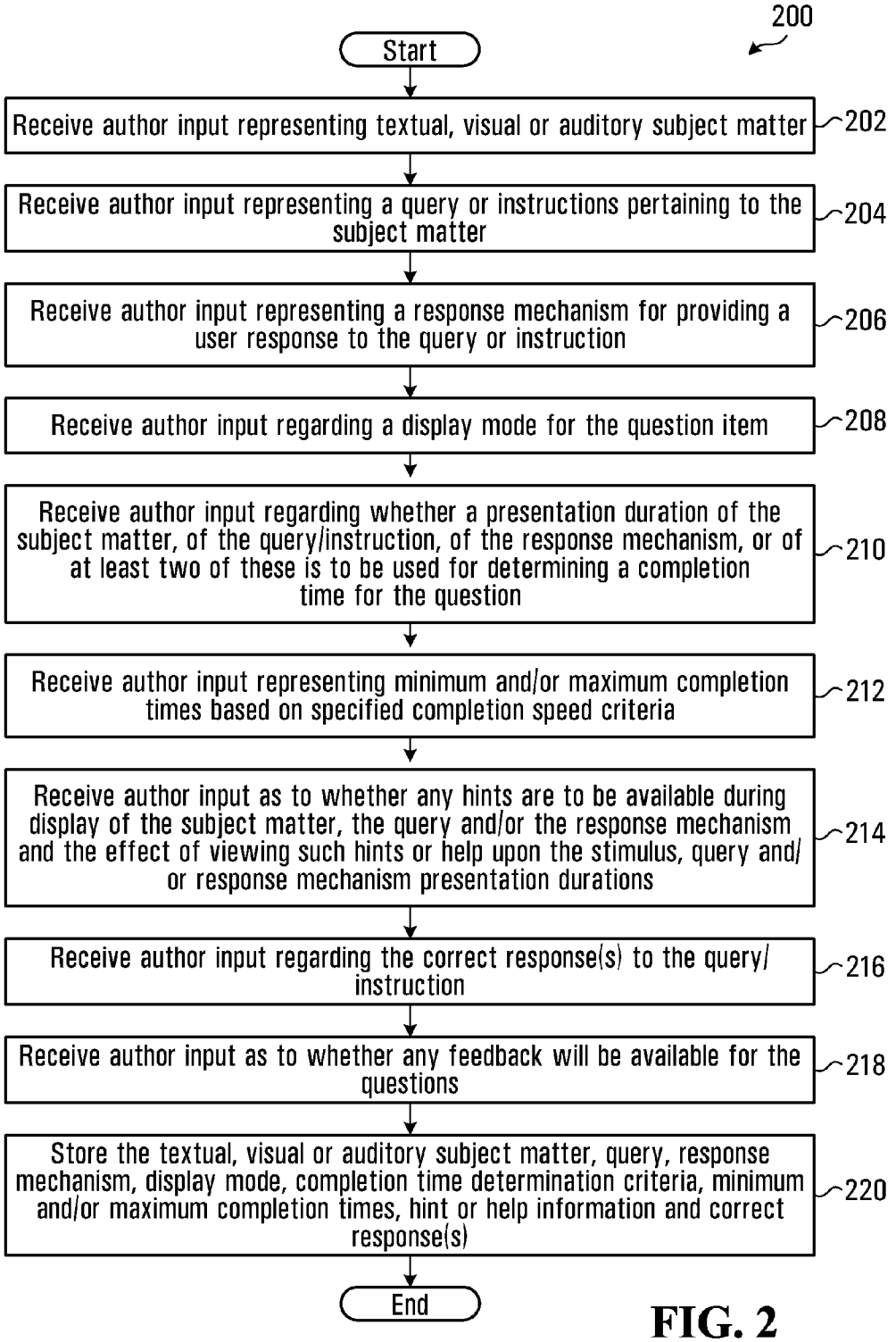

200
Start
Receive author input representing textual, visual or auditory subject matter
202
Receive author input representing a query or instructions pertaining to the subject matter
204
Receive author input representing a response mechanism for providing a user response to the query or instruction
206
Receive author input regarding a display mode for the question item
208
Receive author input regarding whether a presentation duration of the subject matter, of the query/instruction, of the response mechanism, or of at least two of these is to be used for determining a completion time for the question
210
Receive author input representing minimum and/or maximum completion times based on specified completion speed criteria
212
Receive author input as to whether any hints are to be available during display of the subject matter, the query and/or the response mechanism and the effect of viewing such hints or help upon the stimulus, query and/or response mechanism presentation durations
214
Receive author input regarding the correct response(s) to the query/instruction
216
Receive author input as to whether any feedback will be available for the questions
218
Store the textual, visual or auditory subject matter, query, response mechanism, display mode, completion time determination criteria, minimum and/or maximum completion times, hint or help information and correct response(s)
220
End

FIG. 2

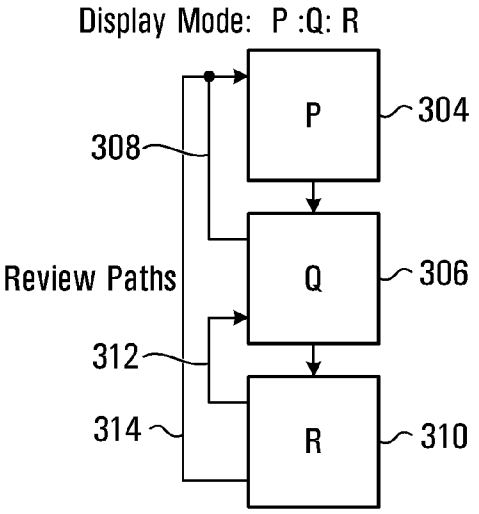


FIG. 3A

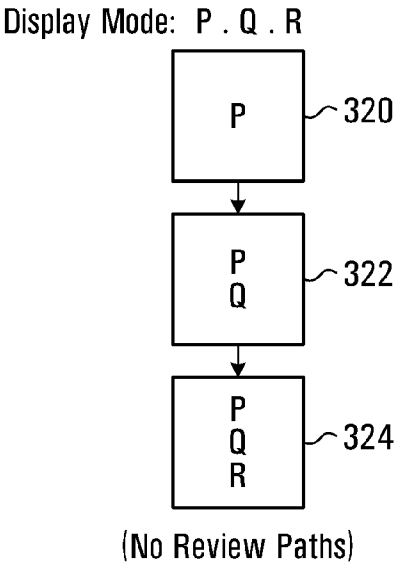


FIG. 3B

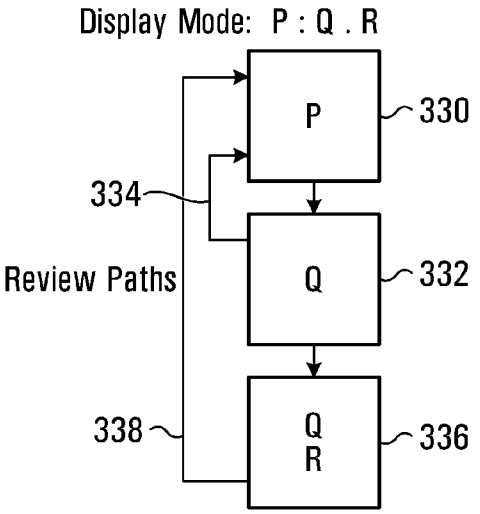


FIG. 3C

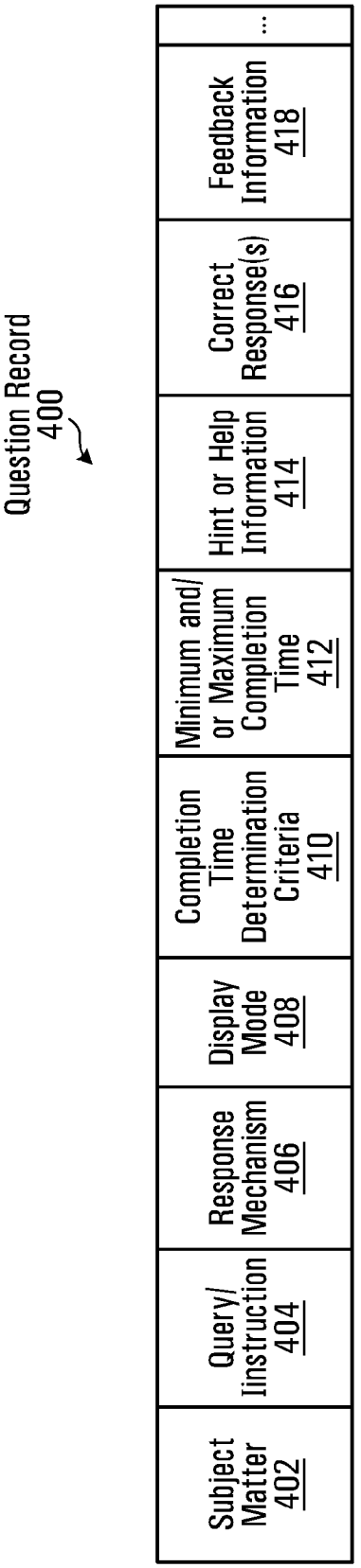

Question Record
400
Subject Matter
402
Query/ Iinstruction
404
Response Mechanism
406
Display Mode
408
Completion Time Determination Criteria
410
Minimum and/ or Maximum Completion Time
412
Hint or Help Information
414
Correct Response(s)
416
Feedback Information
418
...

FIG. 4

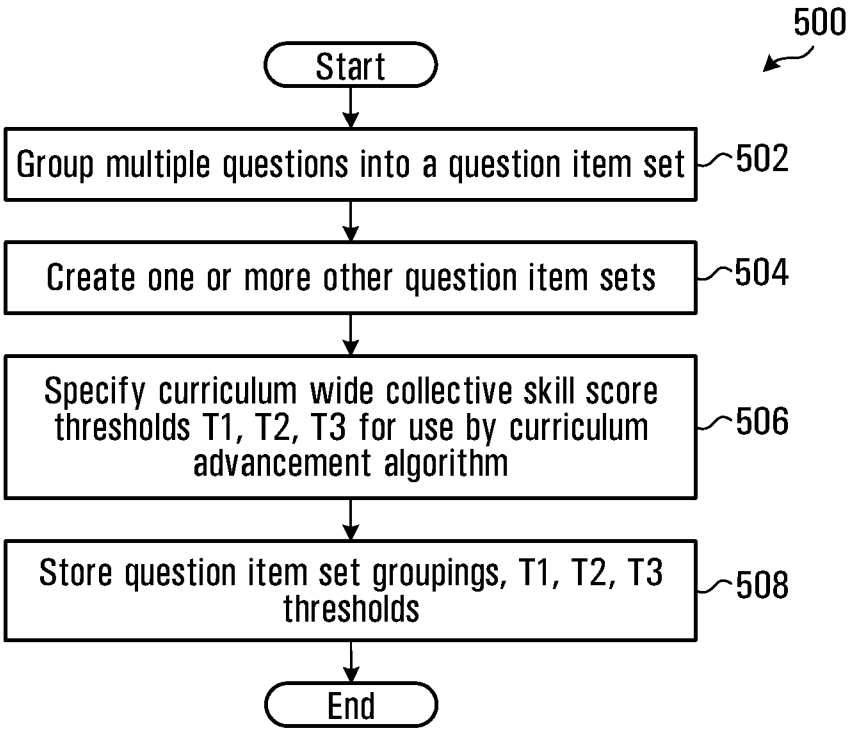

500
Start
Group multiple questions into a question item set
502
Create one or more other question item sets
504
Specify curriculum wide collective skill score thresholds T1, T2, T3 for use by curriculum advancement algorithm
506
Store question item set groupings, T1, T2, T3 thresholds
508
End

FIG. 5

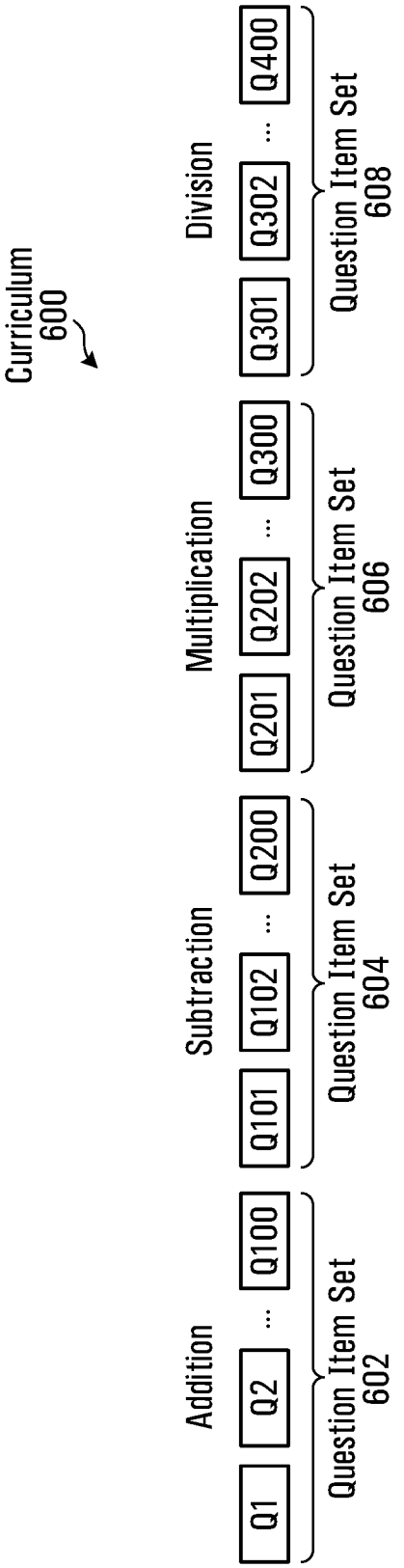

Curriculum
600
Addition
Q1
Q2
...
Q100
Question Item Set
602
Subtraction
Q101
Q102
...
Q200
Question Item Set
604
Multiplication
Q201
Q202
...
Q300
Question Item Set
606
Division
Q301
Q302
...
Q400
Question Item Set
608

FIG. 6

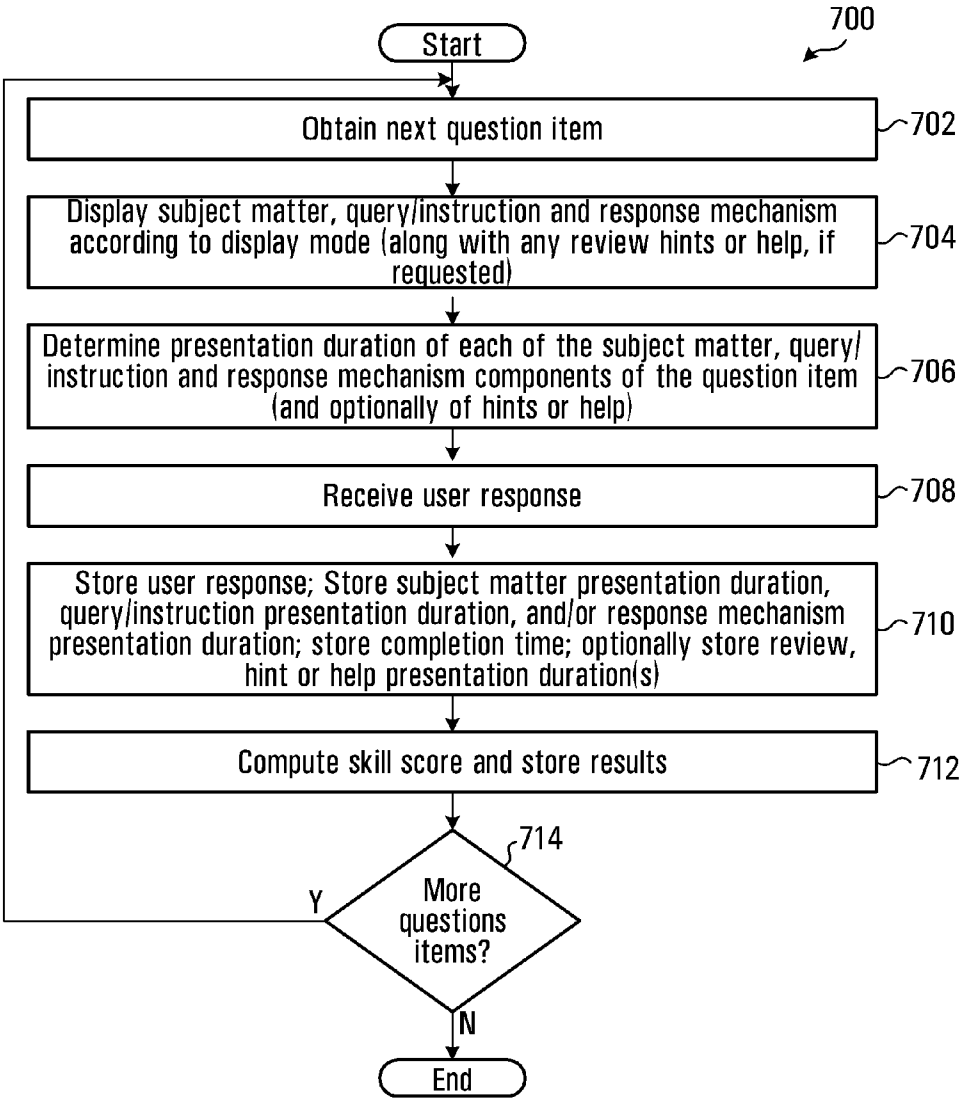

700
Start
Obtain next question item
702
Display subject matter, query/instruction and response mechanism according to display mode (along with any review hints or help, if requested)
704
Determine presentation duration of each of the subject matter, query/instruction and response mechanism components of the question item (and optionally of hints or help)
706
Receive user response
708
Store user response; Store subject matter presentation duration, query/instruction presentation duration, and/or response mechanism presentation duration; store completion time; optionally store review, hint or help presentation duration(s)
710
Compute skill score and store results
712
714
More questions items?
Y
N
End

FIG. 7

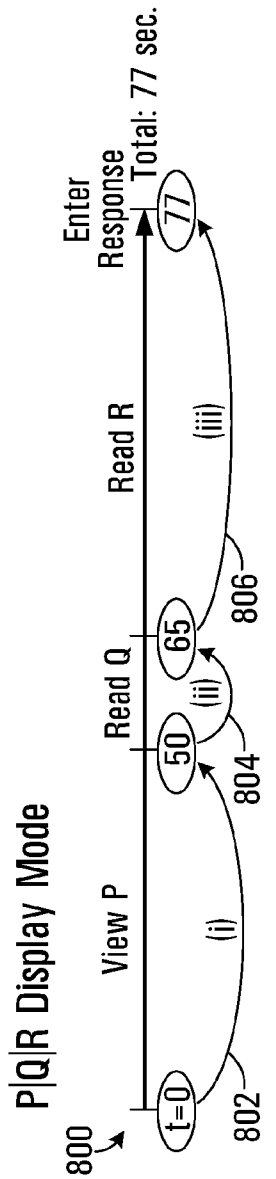


FIG. 8A

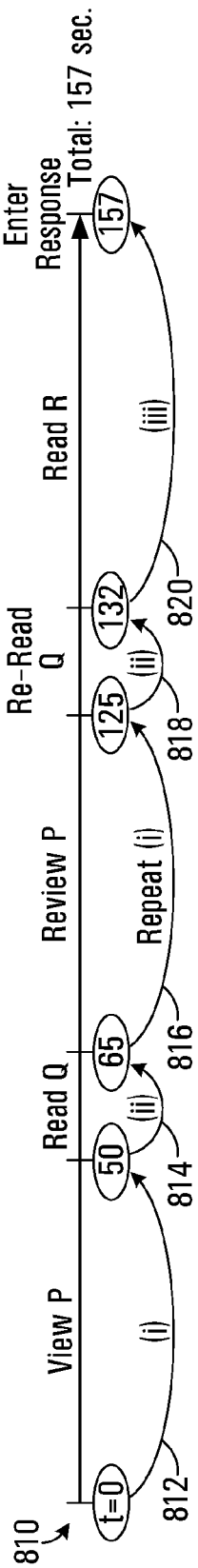


FIG. 8B

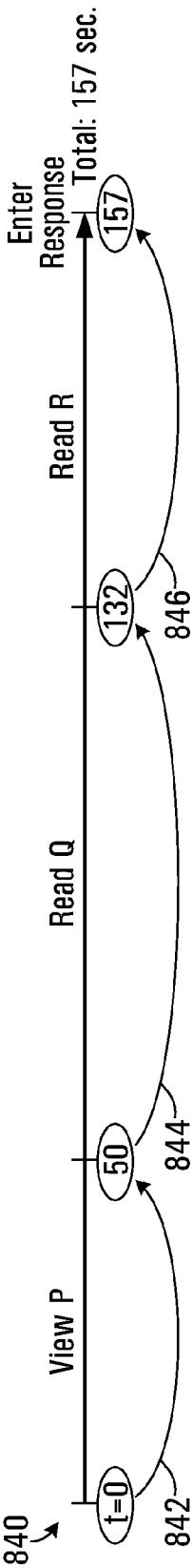


FIG. 8C

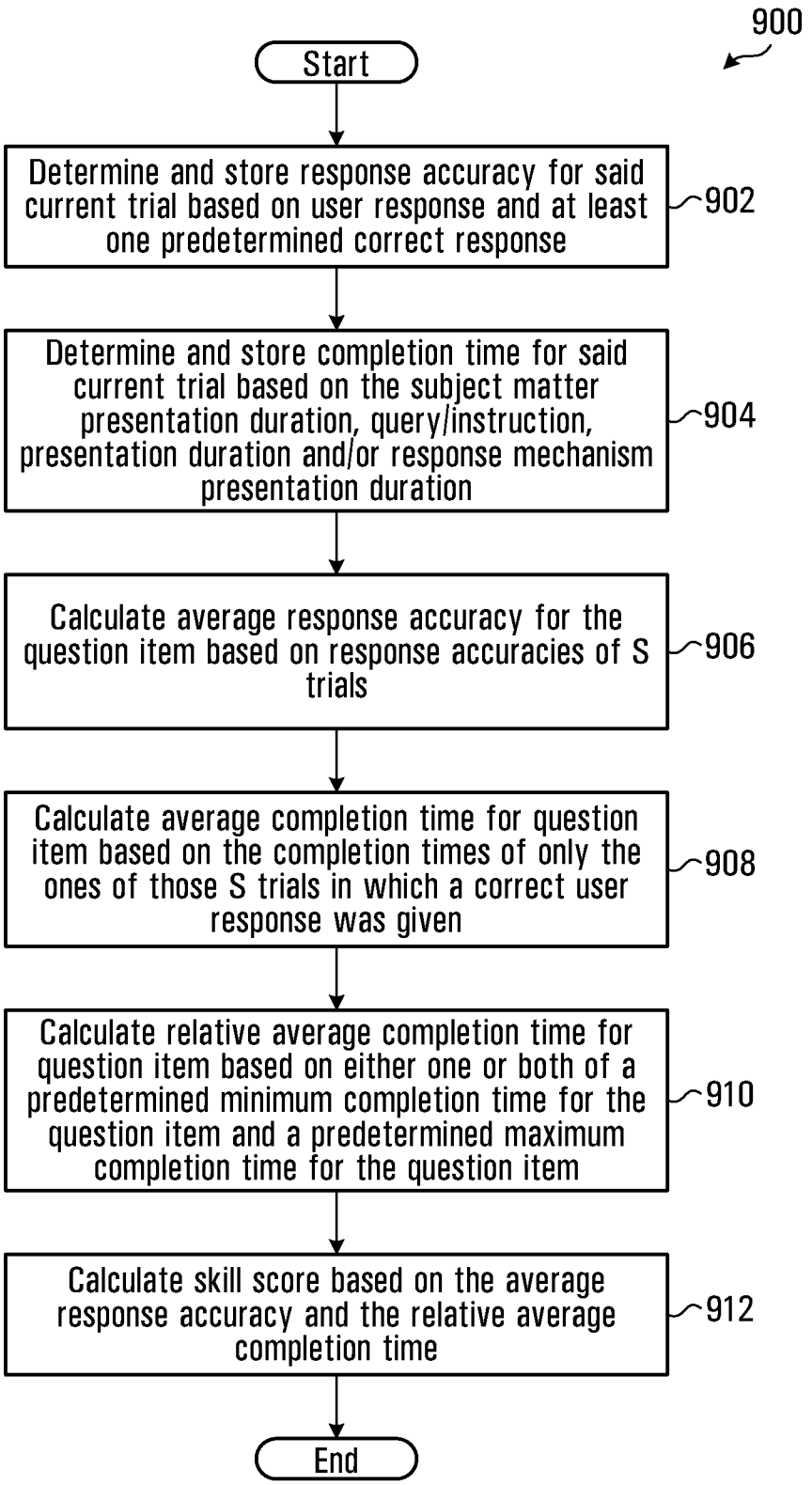
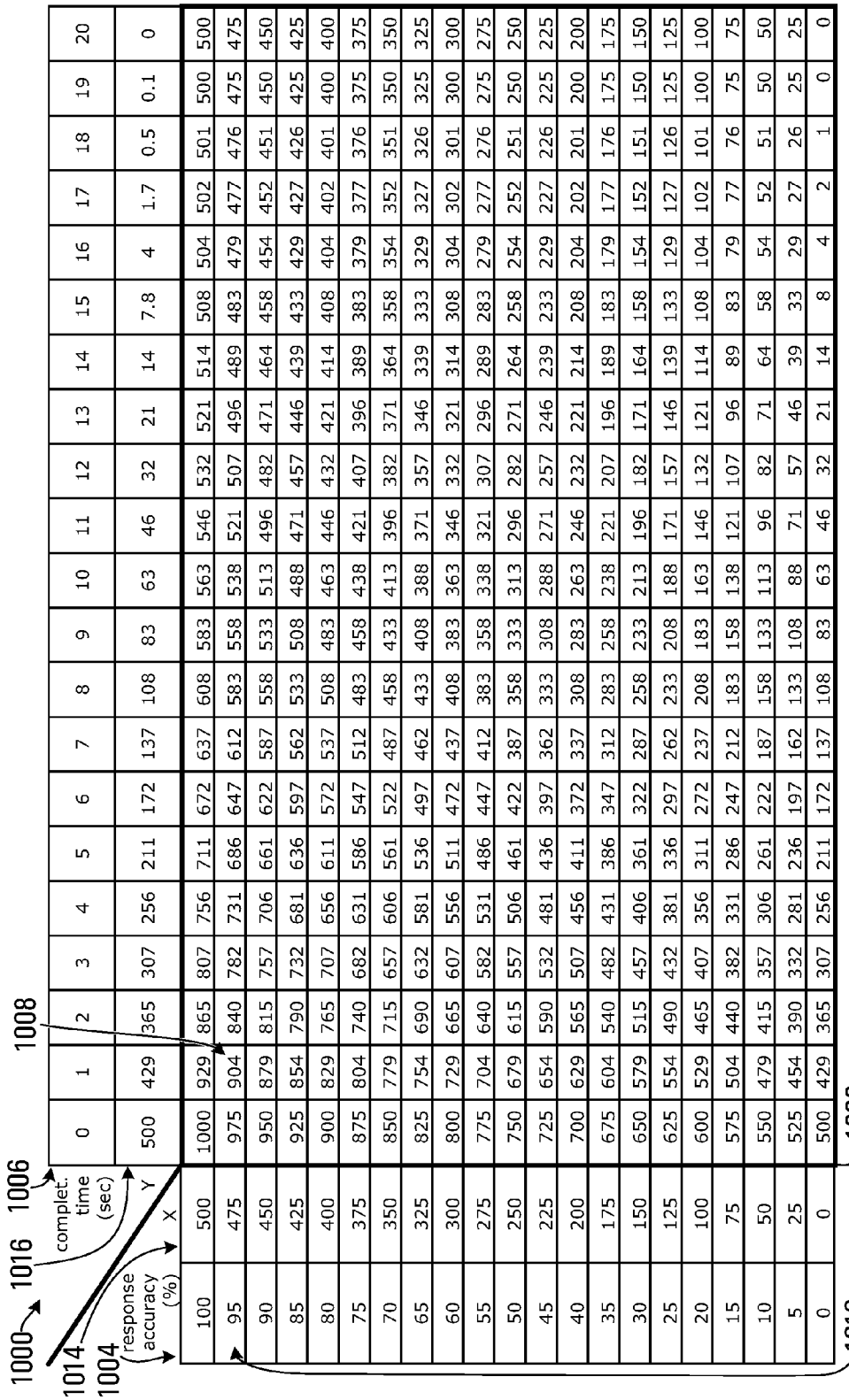

900
Start
Determine and store response accuracy for said current trial based on user response and at least one predetermined correct response
902
Determine and store completion time for said current trial based on the subject matter presentation duration, query/instruction, presentation duration and/or response mechanism presentation duration
904
Calculate average response accuracy for the question item based on response accuracies of S trials
906
Calculate average completion time for question item based on the completion times of only the ones of those S trials in which a correct user response was given
908
Calculate relative average completion time for question item based on either one or both of a predetermined minimum completion time for the question item and a predetermined maximum completion time for the question item
910
Calculate skill score based on the average response accuracy and the relative average completion time
912
End

FIG. 9



X \ Y	500	429	365	307	256	211	172	137	108	83	63	46	32	21	14	7.8	4	1.7	0.5	0.1	0
100	1000	929	865	807	756	711	672	637	608	583	563	546	532	521	514	508	504	502	501	500	500
95	975	904	840	782	731	686	647	612	583	558	538	521	507	496	489	483	479	477	476	475	475
90	950	879	815	757	706	661	622	587	558	533	513	496	482	471	464	458	454	452	451	450	450
85	925	854	790	732	681	636	597	562	533	508	488	471	457	446	439	433	429	427	426	425	425
80	900	829	765	707	656	611	572	537	508	483	463	446	432	421	414	408	404	402	401	400	400
75	875	804	740	682	631	586	547	512	483	458	438	421	407	396	389	383	379	377	376	375	375
70	850	779	715	657	606	561	522	487	458	433	413	396	382	371	364	358	354	352	351	350	350
65	825	754	690	632	581	536	497	462	433	408	388	371	357	346	339	333	329	327	326	325	325
60	800	729	665	607	556	511	472	437	408	383	363	346	332	321	314	308	304	302	301	300	300
55	775	704	640	582	531	486	447	412	383	358	338	321	307	296	289	283	279	277	276	275	275
50	750	679	615	557	506	461	422	387	358	333	313	296	282	271	264	258	254	252	251	250	250
45	725	654	590	532	481	436	397	362	333	308	288	271	257	246	239	233	229	227	226	225	225
40	700	629	565	507	456	411	372	337	308	283	263	246	232	221	214	208	204	202	201	200	200
35	675	604	540	482	431	386	347	312	283	258	238	221	207	196	189	183	179	177	176	175	175
30	650	579	515	457	406	361	322	287	258	233	213	196	182	171	164	158	154	152	151	150	150
25	625	554	490	432	381	336	297	262	233	208	188	171	157	146	139	133	129	127	126	125	125
20	600	529	465	407	356	311	272	237	208	183	163	146	132	121	114	108	104	102	101	100	100
15	575	504	440	382	331	286	247	212	183	158	138	121	107	96	89	83	79	77	76	75	75
10	550	479	415	357	306	261	222	187	158	133	113	96	82	71	64	58	54	52	51	50	50
5	525	454	390	332	281	236	197	162	133	108	88	71	57	46	39	33	29	27	26	25	25
0	500	429	365	307	256	211	172	137	108	83	63	46	32	21	14	8	4	2	1	0	0

FIG. 10

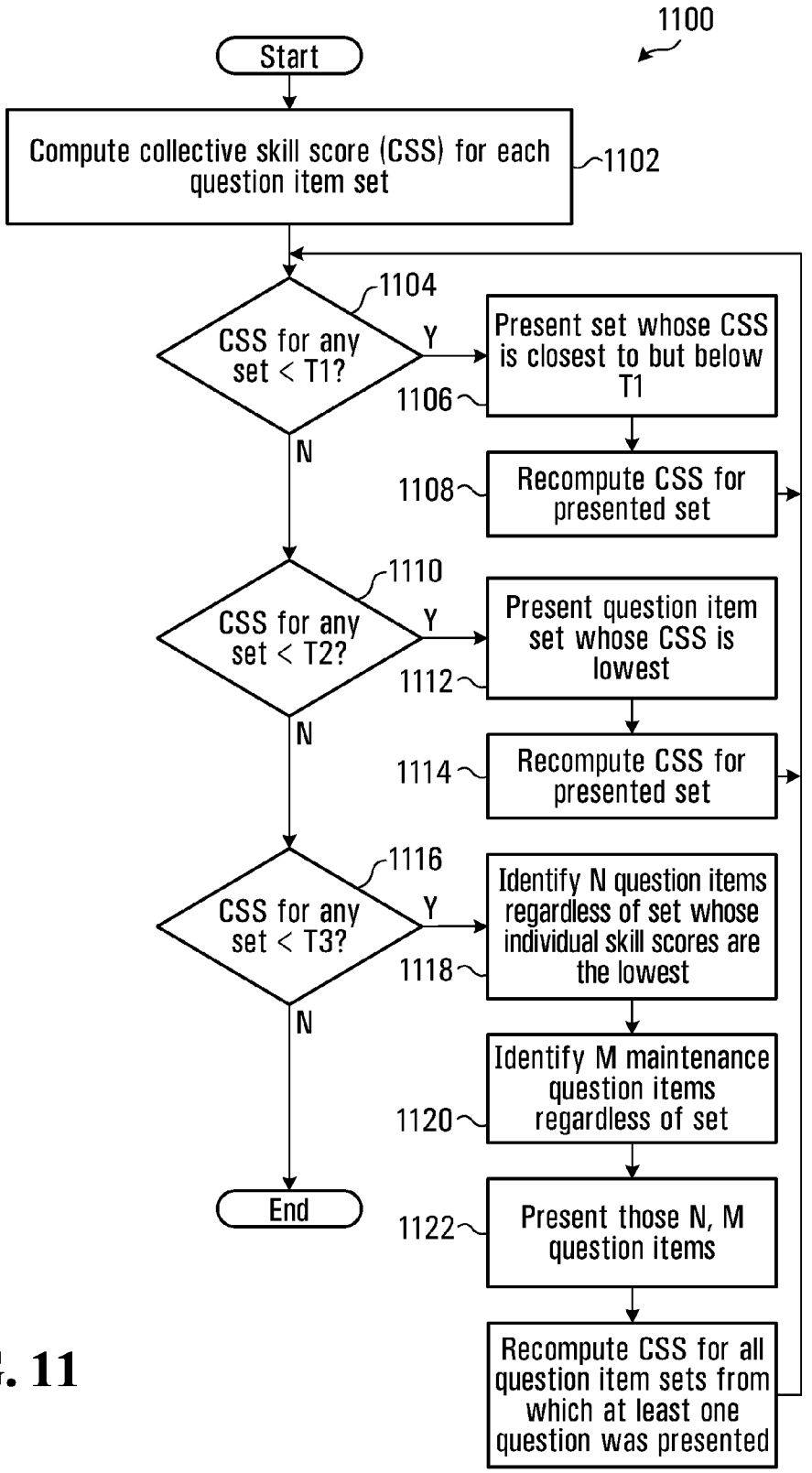
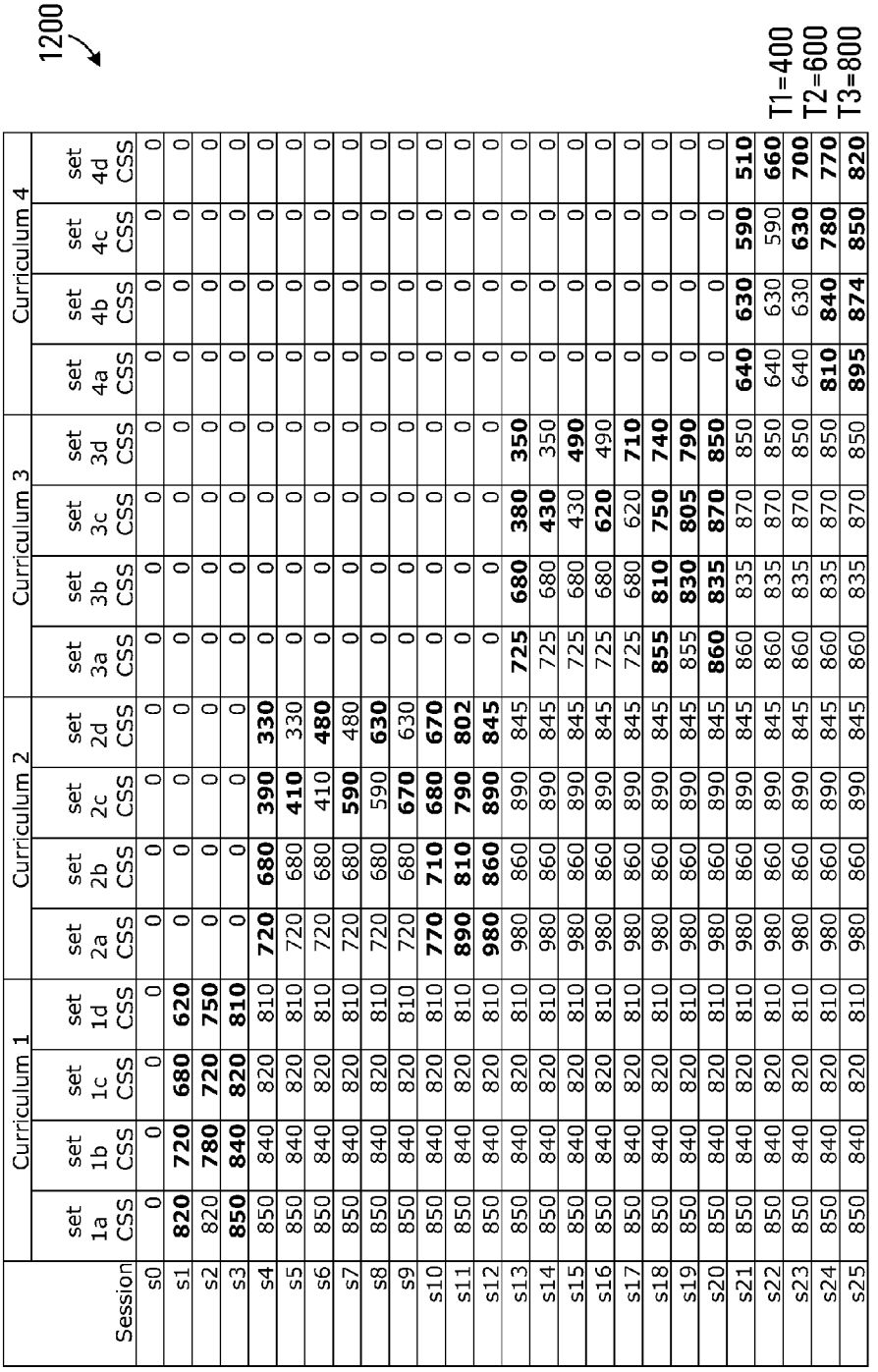

1100
Start
Compute collective skill score (CSS) for each question item set
1102
1104
CSS for any set < T1?
Y
Present set whose CSS is closest to but below T1
1106
N
1108
Recompute CSS for presented set
1110
CSS for any set < T2?
Y
Present question item set whose CSS is lowest
1112
N
1114
Recompute CSS for presented set
1116
CSS for any set < T3?
Y
Identify N question items regardless of set whose individual skill scores are the lowest
1118
N
Identify M maintenance question items regardless of set
1120
End
1122
Present those N, M question items
Recompute CSS for all question item sets from which at least one question was presented

FIG. 11



Session	Curriculum 1				Curriculum 2				Curriculum 3				Curriculum 4			
	set 1a CSS	set 1b CSS	set 1c CSS	set 1d CSS	set 2a CSS	set 2b CSS	set 2c CSS	set 2d CSS	set 3a CSS	set 3b CSS	set 3c CSS	set 3d CSS	set 4a CSS	set 4b CSS	set 4c CSS	set 4d CSS
s0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
s1	**820**	**720**	**680**	**620**	0	0	0	0	0	0	0	0	0	0	0	0
s2	820	**780**	**720**	**750**	0	0	0	0	0	0	0	0	0	0	0	0
s3	**850**	**840**	**820**	**810**	0	0	0	0	0	0	0	0	0	0	0	0
s4	850	840	820	810	**720**	**680**	**390**	**330**	0	0	0	0	0	0	0	0
s5	850	840	820	810	720	680	**410**	330	0	0	0	0	0	0	0	0
s6	850	840	820	810	720	680	410	**480**	0	0	0	0	0	0	0	0
s7	850	840	820	810	720	680	**590**	480	0	0	0	0	0	0	0	0
s8	850	840	820	810	720	680	590	**630**	0	0	0	0	0	0	0	0
s9	850	840	820	810	720	680	**670**	630	0	0	0	0	0	0	0	0
s10	850	840	820	810	**770**	**710**	**680**	**670**	0	0	0	0	0	0	0	0
s11	850	840	820	810	**890**	**810**	**790**	**802**	0	0	0	0	0	0	0	0
s12	850	840	820	810	**980**	**860**	**890**	**845**	0	0	0	0	0	0	0	0
s13	850	840	820	810	980	860	890	845	**725**	**680**	**380**	**350**	0	0	0	0
s14	850	840	820	810	980	860	890	845	725	680	**430**	350	0	0	0	0
s15	850	840	820	810	980	860	890	845	725	680	430	**490**	0	0	0	0
s16	850	840	820	810	980	860	890	845	725	680	**620**	490	0	0	0	0
s17	850	840	820	810	980	860	890	845	725	680	620	**710**	0	0	0	0
s18	850	840	820	810	980	860	890	845	**855**	**810**	**750**	**740**	0	0	0	0
s19	850	840	820	810	980	860	890	845	855	**830**	**805**	**790**	0	0	0	0
s20	850	840	820	810	980	860	890	845	**860**	**835**	**870**	**850**	0	0	0	0
s21	850	840	820	810	980	860	890	845	860	835	870	850	**640**	**630**	**590**	**510**
s22	850	840	820	810	980	860	890	845	860	835	870	850	640	630	590	**660**
s23	850	840	820	810	980	860	890	845	860	835	870	850	640	630	**630**	**700**
s24	850	840	820	810	980	860	890	845	860	835	870	850	**810**	**840**	**780**	**770**
s25	850	840	820	810	980	860	890	845	860	835	870	850	**895**	**874**	**850**	**820**

FIG. 12

ELECTRONIC LEARNING SYSTEM

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application is a continuation of U.S. patent application Ser. No. 13/949,734 filed Jul. 24, 2013, which claims priority from U.S. patent application Ser. No. 12/342,281 filed Dec. 23, 2008, U.S. Pat. No. 8,506,305, the contents of both of which are incorporated herein by reference.

FIELD OF TECHNOLOGY

[0002] The present disclosure relates to electronic learning systems, such as adaptive and remediative electronic learning systems, and to associated methods, software and computing devices.

BACKGROUND

[0003] Electronic learning systems are systems that present a curriculum to a user (e.g. a student) for the purpose of assessing knowledge and skills and teaching the curriculum to the user. Electronic learning systems are typically computer-based. A typical curriculum consists of multiple question items. Each question item typically includes a query or instruction and a response mechanism for receiving a user response to the query or instruction. An exemplary query may be "What is the capital of New York State?" and the corresponding exemplary response mechanism may be a set of individually selectable (multiple choice) answers or an editable text field into which a user response may be typed. Alternatively, the instruction "Identify the capital of New York State" could be substituted for the above query.

[0004] When an electronic learning system presents a question item to a user, the query or instruction and response mechanism are typically displayed at the same time, e.g. on a single computer screen. The user's response may be recorded, possibly along with a measured totality of elapsed time between presentation of the question item and the entry of a user response. A user proficiency measure may be generated based on the accuracy of the user's responses.

[0005] An improved electronic learning system would be desirable.

SUMMARY

[0006] In one aspect of the present invention, there is provided a machine-readable medium storing instructions for presenting a question item of an electronic learning curriculum, said instructions, when executed by a processor of a computing device, causing said computing device to: (a) retrieve from a data store a question item comprising: textual, visual or auditory subject matter; a query or instruction pertaining to said subject matter; and a representation of a response mechanism for receiving a user response to said query or instruction; (b) present said subject matter, said query or instruction and said response mechanism in a presentation sequence, wherein a presentation duration of each of said subject matter, said query or instruction and said response mechanism in said presentation sequence is controlled by user input; (c) based on said user input, determine: a presentation duration of said subject matter; a presentation duration of said query or instruction; and a presentation duration of said response mechanism; and (d) store indicators of each of said three presentation durations.

[0007] In another aspect of the present invention, there is provided a computing device having a processor in communication with memory storing instructions for presenting a question item of an electronic learning curriculum which, when executed by said processor, cause said computing device to: (a) retrieve from a data store a question item comprising: textual, visual or auditory subject matter; a query or instruction pertaining to said subject matter; and a representation of a response mechanism for receiving a user response to said query or instruction; (b) present said subject matter, said query or instruction and said response mechanism in a presentation sequence, wherein a presentation duration of each of said subject matter, said query or instruction and said response mechanism in said presentation sequence is controlled by user input; (c) based on said user input, determine: a presentation duration of said subject matter; a presentation duration of said query or instruction; and a presentation duration of said response mechanism; and (d) store indicators of each of said three presentation durations.

[0008] In yet another aspect of the present invention, there is provided a machine-readable medium storing instructions that, when executed by a processor of a computing device, cause said computing device to: (a) calculate a user competency measure for each question item in each of a plurality of question item sets comprising an electronic learning curriculum, said calculating being based on an average response accuracy for said question item and an average completion time for said question item over a plurality of trials; (b) for each question item set of said plurality, calculate a collective user competency measure for the set based on the user competency measures of the question items of said set; and (c) automatically select for repeated presentation the question item set whose collective user competency measure is closest to but below a threshold.

DESCRIPTION OF THE DRAWINGS

[0009] Aspects and features of the disclosed embodiments will become apparent to those of ordinary skill in the art upon review of the following description of specific embodiments in conjunction with the accompanying figures. In the figures which illustrate at least one example embodiment:

[0010] FIG. **1** is a schematic diagram illustrating an electronic learning system;

[0011] FIG. **2** is a flowchart illustrating operation for authoring a single question item using the electronic learning system of FIG. **1**;

[0012] FIGS. **3**A-**3**C are schematic diagrams illustrating three exemplary display modes for a question item;

[0013] FIG. **4** is a schematic diagram illustrating an exemplary question item record used by the system of FIG. **1**;

[0014] FIG. **5** is a flowchart illustrating operation for creating a curriculum using the electronic learning system of FIG. **1**;

[0015] FIG. **6** is a schematic diagram illustrating question item set forming part of a curriculum created using the electronic learning system of FIG. **1**;

[0016] FIG. **7** is a flowchart illustrating operation for presenting the question items of a question item set;

[0017] FIGS. **8**A-**8**C are schematic diagrams illustrating user interaction with three exemplary question items, each having a different display mode;

[0018] FIG. **9** is a flowchart illustrating operation for computing a user competency measure for a question item;

[0019] FIG. **10** is a table illustrating exemplary user competency measures as may be computed by the system of FIG. **1**;

[0020] FIG. **11** is a flowchart illustrating an exemplary curriculum advancement algorithm used by the system of FIG. **1**; and

[0021] FIG. **12** is a table illustrating advancement of a user from a beginner skill level to an expert skill level according to the algorithm of FIG. **11**.

DETAILED DESCRIPTION

[0022] Referring to FIG. **1**, an exemplary electronic learning system **10** is illustrated. The system **10** includes an authoring workstation **12** for authoring an electronic learning curriculum and a user workstation **14** for using the electronic learning curriculum. The workstations **12** and **14** each communicate with a curriculum server **16** over a network **18**. During an authoring stage, an author interacts with authoring workstation **12** to create an electronic learning curriculum, which is uploaded to the curriculum server **16**. During a subsequent use stage, a user (e.g. a student) interacting with user workstation **14** accesses the curriculum stored at server **16** during one or more sessions for the purpose of learning the curriculum. The authoring and use stages will be described in detail below.

[0023] Each of the authoring workstation **12** and user workstation **14** is a computing device having a display and at least one processor in communication with memory storing software in the form of processor executable instructions. The workstations **12** and **14** may for example be conventional multipurpose desktop computers, laptop computers, palmtop computers, mobile wireless communication devices or portable digital assistants, modified for operation as described herein. The term "workstation" as used herein should not be understood to connote a particular device architecture. The authoring workstation **12** is not necessarily the same type of computing device as the user workstation **14**. The term "computing device" as used herein is understood to encompass any device (electronic or otherwise) capable of performing computations including, but not limited to, the devices enumerated above, and possibly including future computing device such as implants, or computer aided prosthetics. Each of the workstations **12**, **14**, has a network interface for communication over network **18**. The software that is stored in memory at the workstations **12** or **14** may be loaded into memory from machine-readable medium **20** or **22** (respectively), which may for example be an optical disk, a form of magnetic storage medium such as a memory stick, hard disk drive, flash drive or another form of tangible storage medium capable of being read by a computing device, or received over a network from a remote source. The software at the author's workstation **12** includes a software application (possibly a web browser) by which the electronic learning curriculum is authored while the software at the user workstation **14** includes a software application (also possibly a web browser) by which the electronic learning by the curriculum is remotely accessed.

[0024] Curriculum server **16** is a computing device having at least one processor in communication with a data store (e.g. volatile or nonvolatile memory such as RAM, ROM or secondary storage) storing at least one electronic learning curriculum for remote access by users at workstation **14**. In the present embodiment, the server **16** stores only one exemplary electronic learning curriculum, however it will be appreciated that many electronic learning curricula could be stored at curriculum server **16** in alternative embodiments. The curriculum server also stores software for presenting the electronic learning curriculum. This may comprise web server software that permits the electronic learning curriculum to be accessed by users at remote workstations executing web browser applications. The curriculum server software may be loaded from a machine-readable medium **24**, which may for example be an optical disk, magnetic storage medium or another form of tangible storage medium capable of being read by a computing device, or received over a network from a remote source. The curriculum server **16** also has a network interface for communication over network **18**.

[0025] Network **18** is a conventional data network or network of data networks. The primary role of network **18** within system **10** is to permit an author to upload the electronic learning curriculum from authoring workstation **12** to curriculum server **16** upon completion of the authoring stage and to permit a user at user workstation **14** to remotely access the electronic learning curriculum from the curriculum server **16** during the use stage. Network **18** may for example be the Internet, an intranet, or a proprietary data network.

Authoring Stage

[0026] During the authoring stage, an author creates an electronic learning curriculum made up of a plurality of question items. Each question item in the curriculum has three components that shall be presented to the user in a presentation sequence during the use stage. The first component is textual, visual or auditory subject matter, referred to as the presentation component (or "P component"). The P component may be considered to represent the subject matter of the question item, i.e. what the question item is about. The P component may comprise combinations of textual, visual and/or auditory subject matter (e.g. a video clip including text having a sound track, text with accompanying audio, etc.). The second component is a query or instruction pertaining to the subject matter, referred to as the query component (or "Q component"). The third component is a response mechanism for receiving a user response to the query or instruction, referred to as the response component (or "R component"). The R component is a mechanism for receiving a user response. These three components are not necessarily presented in the order P, Q, R.

[0027] In an exemplary question item forming part of an electronic learning curriculum for medical students, the subject matter may be an X-ray image illustrating a fractured bone; the query or instruction may be "What type of fracture is illustrated?" or "Identify the type of fracture"; and the response mechanism may be a multiple choice response mechanism providing a number of individually-selectable responses, each naming a different type of fracture, and permitting the user's response to be received (e.g. as a selection of, say, a radio button graphical user interface (GUI) element).

[0028] In overview, when creating a question item for an electronic learning curriculum, the author specifies P, Q and R components for that question item. The author also selects a display mode for the question item. The display mode determines the presentation sequence for the P, Q and R components. In the present embodiment, the order of presentation is either "P then Q then R" or "Q then P then R". In other words, the presentation sequence comprises: (i) presenting one of P and Q; then (ii) presenting the other of P and Q; then (iii)

presenting R. The display of successive question item components may be either cumulative (i.e. display the succeeding component without removing the preceding component, so that both are shown together when the succeeding component appears) or consecutive (i.e. replace the preceding component with the succeeding component, so that the components are shown one at a time). Although not required in all embodiments, the display mode may also stipulate whether it is possible to review earlier displayed but no longer visible question item components (in the case of consecutively displayed question item components).

[0029] Exemplary operation **200** for authoring a single question item is shown in FIG. **2**. Referring to FIG. **2**, author input representing the P component, i.e. textual, visual or auditory subject matter (including combinations of textual, visual and/or auditory subject matter), is received (**202**). The subject matter may take various forms, including but not limited to text, an image, a video clip, an audio clip, an animation, an interactive animation (such as Adobe® Macromedia® Flash® or Microsoft® PowerPoint™), content created for a third party or commercially available application (e.g. Mathematica® or Excel®), possibly executed by way of a macro or the like. The subject matter input may be provided by the author at the authoring workstation **12** in various ways. It may be loaded from a machine-readable medium **20**, received over a network from a remote source, or directly provided by the author through interaction with the authoring workstation **12**, possibly by way of one or more input devices (e.g. by way of an interconnected keyboard, mouse, scanner, camcorder or the like). Alternatively, it may be identified by way of one or more links (e.g. a hyperlink to web-based content).

[0030] Next, author input representing the Q component, i.e. a query or instruction pertaining to the P component, is received (**204**). The query or instruction may be a textual query or instruction and, as such, it may be typed by the author using a keyboard of authoring workstation **12**. Alternatively, it may be loaded from medium **20** or received over a network from a remote source, possibly in a similar fashion to the P component. The Q component could alternatively be non-textual (e.g. it could be an audio clip, video clip, or any other format in which the P component may be specified). It will be appreciated that the Q component may in some cases be an instruction, e.g. "Select one of the following four cities as the city having the largest population", and is thus not necessarily in the form of a question.

[0031] Thereafter, author input representing the R component, i.e. a response mechanism for receiving a user response, is received (**206**). During authoring, specification of the R component may be facilitated by authoring software that provides a graphical user interface (GUI) element at the authoring workstation **12** inviting the author to select a desired response mechanism from a list of different response mechanisms, such as: multiple choice (with either one or more than one correct answer, e.g. "choose all that apply"); true or false (a specific form of multiple choice); binary (e.g. user selection/non-selection of a single choice, such as "I accept"); fill in the blank (e.g. single word or short phrase typed into a field); multiple blank (e.g. a "fill in the blanks" questionnaire); short answer (e.g. a sentence or paragraph); essay answer (similar to short answer but possibly spanning multiple paragraphs). When "multiple choice" is selected, the author may be prompted to indicate how many foils (i.e. choices) there will be and to provide the substance of each choice (e.g. by typing the foil or, if the foils are non-textual such as graphical or auditory, by providing the appropriate input for each foil and to provide the substance of any feedback, in any format, that the user could experience upon selecting the foils). The author also provides the substance of the hints, if any, available for each component and/or for each foil.

[0032] It will be appreciated that the response mechanism may be unrelated to whatever user input mechanism may be used to receive input indicative of a user response at the user workstation **14**. Various user input mechanisms may be used to interact with the response mechanism, such as pointing devices (mouse, touchscreen or trackball); keyboards (e.g. press 'Z' for yes or 'M' for no, or other keys, possibly multiple keys); audio capture of vocalized response (e.g. digital voice recording); measuring of physiological responses (e.g. heart rate, breathing rate, pupil dilation, etc., during a response interval); video capture; haptic response devices; various types of peripheral devices such as joysticks, video game controllers, inertial sensors as in the Wii™ game controller; clicker devices; combinations of these; or others.

[0033] It will be appreciated that operation **202**, **204**, **206** of FIG. **2** can occur in any order.

[0034] Next, the author selects a display mode for the question item which determines a presentation sequence for the P, Q and R components when the question item is presented in the use stage. In the present embodiment (although not necessarily in all embodiments), the display mode also determines whether the subject matter, the query or instruction and the response mechanism shall be displayed to a user consecutively, cumulatively or using a combination of these approaches (**208**, FIG. **2**).

[0035] In the present embodiment (although not necessarily in all embodiments), the display mode further determines whether it is possible for a user to review earlier displayed but no longer available question item components (in the case when question item components are consecutively displayed), e.g. by selecting a "review" button to repeat the presenting of an earlier displayed component after it has been replaced by a subsequent component. In the present embodiment (although not necessarily in all embodiments), the author selects a display mode at authoring workstation **12** by selecting from one of eighteen display mode options shown in Table 1 below. Table 1 adopts a notation wherein the display mode is represented by an expression containing the letters P, Q and R (representing the presentation, query/instruction and response mechanism question item components, respectively) with a symbol between adjacent letters signifying consecutive or cumulative display of the components represented by the adjacent letters, as follows:

[0036] Consecutive display: a ":" (colon) symbol between letters signifies consecutive display of the two represented components, e.g. "P:Q" means "display P then (later) replace P with Q". In the present embodiment, the colon symbol also connotes that review of the earlier displayed component is available prior to entry of a user response (e.g. upon detection of a user input event indicating that review is desired, P shall be presented anew so as to replace Q). A "|" (vertical bar) symbol between letters is the same as a ":" symbol, i.e. it also signifies consecutive display of the two represented components, except that review of the earlier displayed component prior to entry of a user response is precluded. Depending upon the embodiment, the author may or may not have direct, question item by question item control as to whether review

shall be available (e.g. in some embodiments, review may always be available to the user for all question items, or it may never be available to the user for any question item; the author may be able to specify review paths globally for the entire question item set).

[0037] Cumulative display: a "." (period or dot) symbol between letters signifies cumulative display of the two represented components, e.g. "P.Q" means "display P then (later) add 0" (i.e. without removing P).

[0038] Using this notation, eighteen display modes are possible in the present embodiment, as follows:

TABLE 1

Display Modes

#	Notation	Meaning
1.	P:Q:R	display P; then, replace P with Q; then, replace Q with R (review of P, Q available)
2.	Q:P:R	display Q; then, replace Q with P; then, replace P with R (review of Q, P available)
3.	P:Q|R	display P; then, replace P with Q (review of P available); then, replace Q with R (at which time review of P, Q is unavailable)
4.	Q:P|R	display Q; then, replace Q with P (review of Q available); then, replace P with R (at which time review of P, Q is unavailable)
5.	P:Q.R	display P; then, replace P with Q; add R then (review of P available)
6.	Q:P.R	display Q; then, replace Q with P; add R then (review of Q available)
7.	P|Q:R	display P; then, replace P with Q; then, replace Q with R (review of only Q available)
8.	Q|P:R	display Q; then, replace Q with P; then, replace P with R (review of only P available)
9.	P|Q|R	display P; then, replace P with Q (review of P unavailable); then replace Q with R (review of P, Q unavailable)
10.	Q|P|R	display Q; then, replace Q with P (review of Q unavailable); then replace P with R (review of Q, P unavailable)
11.	P|Q.R	display P; then, replace P with Q; add R then (review of P unavailable)
12.	Q|P.R	display Q; then, replace Q with P; add R then (review of Q unavailable)
13.	P.Q:R	display P; then, add Q; then, replace both with R (review of P, Q available)
14.	Q.P:R	display Q; then, add P; then, replace both with R (review of Q, P available)
15.	P.Q|R	display P; then, add Q; then, replace both with R (review of P, Q unavailable)
16.	Q.P|R	display Q; then, add P; then, replace both with R (review of Q, P unavailable)
17.	P.Q.R	display P; then add Q; then, add R
18.	P.Q.R	display Q; then add P; then, add R

[0039] It will be appreciated that some display modes provide for the review of an earlier displayed but no longer visible question item component while others do not. Review of an earlier displayed question item component is only available when the display mode involves consecutive display of two (or more) of the P, Q and R components. The reason is that, when only cumulative display mode is used, all of the P, Q and R elements are, or will ultimately be, displayed together, obviating any need for review.

[0040] For illustration, three different display modes, two having the capacity for review of an earlier displayed question item component and one lacking this capacity, are illustrated in FIGS. **3**A-**3**C. In these figures, each box is a symbolic representation of what a user will see on a display of user workstation **14** at a particular moment in time, with arrows between boxes illustrating user advancement through the sequential presentation of question item components.

[0041] FIG. **3**A, illustrates display mode P:Q:R. Initially, only the P component is presented (box **304**), e.g. on the display and/or speakers of user workstation **14** (depending whether P is visual/textual or auditory, respectively). If the P component is an audio or video clip, it may be presented with a set of controls (e.g. play, pause, rewind, fast forward, or go to beginning) that may permit the user to manipulate the audio/video, including playing it more than once or stopping it before completion. When the user advances to the next component (typically by selecting a "next" button), the Q component replaces the P component (box **306**) such that the P component is no longer available on the screen for viewing/listening to (e.g. the play, pause etc. controls disappear). At this stage, the user can return to the P component via review path **308**, if desired, e.g. by selecting a "Review subject matter" button. In the case of an audio/video clip, this may cause the above-described controls to reappear. Alternatively, upon further advancement, the R component replaces the Q component (box **310**) such that neither of the P or Q components is available on the screen. At this stage, the user can either return to the Q component via review path **312** or return to the P component via review path **314**, if desired, e.g. by selecting a "Review subject matter" button or a "Review query/instruction" button, respectively. It is noted that, if the ":" symbols in "P:Q:R" were each replaced with the "I" symbol, review paths **308**, **312** and **314** would be omitted from FIG. **3**A.

[0042] Turning to FIG. **3**B, which illustrates display mode P.Q.R, it can be seen that when the question item is initially displayed, only the P component is presented (box **320**). Upon advancement, the Q component is added to the P component, so that both are now presented together (box **322**). Upon further advancement, the R component is added to the P and Q components (box **324**). Because all of the P, Q and R question item components are ultimately presented together,

reviewing a previously viewed question item component is meaningless for this display mode, as all of the question item components are already visible. Accordingly, no review paths are available. If either of P or Q is a video or audio clip, it may be presented with a set of controls (e.g. play, pause, rewind, fast forward, or go to beginning) that may permit the user to manipulate (e.g. replay) the audio/video even upon presentation of the R component; thus no "review path" per se is necessary.

[0043] Finally, in FIG. **3**C, which illustrates display mode P:Q.R, it can be seen that when the question item is initially displayed, only the P component is presented (box **330**). Upon advancement, the Q component replaces the P component (box **332**). At this stage, the user can return to viewing/hearing the P component via review path **334** if desired. Assuming this is not done, upon further advancement the R component is added to the Q component (box **336**), so that Q and R are displayed together. It will be appreciated that review of Q is meaningless in this situation, since Q is already displayed with R. However, the user could return to the P component via review path **338**, if desired.

[0044] As a further aspect of authoring a question item in the present embodiment (although not necessarily in all embodiments), the author, who is assumed to know that the presentation duration of each of the P, Q and R question item components will be timed during use of the electronic learning curriculum (as described below), also specifies which of the P, Q and/or R component presentation durations should be used for determining a completion time for the question item (FIG. **2**, **210**), i.e. how long the user took to respond to the question item or to complete some aspect of the question item (e.g. viewing the P or Q component). The completion time is indicative of the user's speed of response. It will be used in computing a skill score for the question item, which is a user competency measure that is based upon average response accuracy and relative average completion time over a number of trials during which the user answered the same question item. The author thus specifies, on a per-question item basis, completion time determination criteria dictating which of the P, Q and/or R component presentation durations shall constitute the completion time that is used in the skill score calculation. If the P display duration is specified, this means that the author considers the time spent listening to and/or viewing the subject matter to be relevant to assessing user competency. If the Q display duration is specified, this means that the author considers the time spent viewing the query or instruction to be relevant to assessing user competency. If the R display duration is specified, this means that the author considers the time spent entering a response, including reading foils (for multiple choice question items), is important. The author may specify that the display duration of just one of the P, Q and R components is to form the basis of the completion time, or that a sum of the display durations of two or more components (e.g. the sum of the P, Q and R display durations) is to form the basis for the completion time.

[0045] In the present embodiment, the author further specifies the minimum completion time (CTmin) and/or maximum completion time (CTmax) for the question item (FIG. **2**, **212**). This information is used for the purpose of computing the skill score for the question item, in which the user's completion time over a number of trials in answering the same question item is not considered on an absolute scale, but rather is considered relative to either one or both of minimum and maximum completion times for that question item. The author may specify minimum and/or maximum completion times for each of the P, Q and R components or simply minimum and/or maximum completion times for whichever one(s) of the P, Q and R components shall contribute to the completion time, as specified above (in FIG. **2**, **210**).

[0046] Minimum completion time may for example be specified in any of the following ways:

[0047] (a) Manually—the author may simply set the minimum completion time to a desired value (e.g. the fastest response for an expert or the fastest possible time in which a user can physically specify the correct answer and click a "submit" button or the like)

[0048] (b) Empirically—the author may set the minimum completion time based on empirically determined values. In one example, some number of experts may be asked to answer the question item for which minimum completion time is being determined. Their average completion time and the standard deviation (μ) are computed. The minimum completion time may then be set at 4μ below the mean. This could vary from 0 to 5μ (or more) below the mean in alternative embodiments (e.g. any score that is more than three standard deviations, i.e. 3μ, from the mean may be considered an "outlier" in statistical terminology, thus using 4μ could be considered conservative for some embodiments). In another example, in the case where the sum of the P, Q and R presentation durations is to be used as the completion time, the minimum completion time may be set based on total number of words in the entire question item (including each of the P, Q and R components) and a typical user's reading speed. In a further example, a database of historical data for many users can be used as the basis for the minimum.

[0049] (c) Dynamically—the minimum value may be set to automatically adjust at run time based on users' performance (e.g. adjust to match a new minimum whenever a new minimum is achieved by any user), with the minimum initially being set to an arbitrary initial value. For example, durations collected from past user performances can be collected and divided into quintiles for each component of each question item. The mean and standard deviation of the best users (e.g. the top 20%) may be used to set the minimum completion time (e.g. set minimum completion time to three times that standard deviation below that mean).

[0050] Similarly, maximum completion time may for example be set in any of the following ways:

[0051] (a) Manually—set by the author to some large value that even the least experienced beginners should be able to beat (or above which there is doubt that the user was paying attention).

[0052] (b) Empirically—the author may set the maximum completion time based on empirically determined values. In one example, some number of beginners may be asked to answer the question item. Their average completion time and standard deviation (p) are computed. Then the maximum completion time may be set at 3μ above the mean. This could vary from 0μ to 5μ (or more) above the mean in alternative embodiments. In a further example, a database of historical data for many users can be used as the basis for the maximum.

[0053] (c) Dynamically—the maximum value may be set to automatically adjust at run time based on users' performance (e.g. adjust to match a new maximum whenever a new maximum is achieved by any user), with the maximum initially being set to an arbitrary initial value. For example, durations collected from past user performances can be

collected and divided into quintiles for each component of each question item. The mean and standard deviation of the worst users (e.g. the bottom 20%) may be used to set the maximum completion time (e.g. set maximum completion time to three times that standard deviation above that mean).

[0054] As yet another aspect of authoring the question item, the author may optionally also specify whether a hint or help can be viewed during electronic learning (**214**) and, if so, what the hint will be. Hints or help may be made available to the user during display of any of the P, Q and R components of the question item, e.g. by way of "hint" or "help" buttons (respectively) presented on the display of user workstation **14**. A hint is typically a textual description that facilitates the user's comprehension of the displayed component(s) or is suggestive of a correct response. Help is typically some sort of textual description that provides basic assistance as to electronic learning curriculum functionality. Hints or help could alternatively or additionally take on forms that are not textual (e.g. graphical, cinematographic, auditory, etc.). The author may also be able to specify the effect of viewing such hints or help upon completion time (i.e. whether time spent viewing hints or help counts towards the P, Q and/or R presentation durations). In some embodiments, this behavior may not be under the author's control (e.g. it may be assumed or hard-coded that time spent viewing hints or help always counts, or never counts, towards completion time).

[0055] The author also provides input regarding the correct response(s) to the question item that is being authored (FIG. **2**, **216**), for use in computing an accuracy component of the skill score for the question item. In the case of a multiple choice R component, the author input may simply be an indication of which foil (i.e. which choice) is correct. In the case of a typed response (e.g. short answer or essay), the author input may be a sample response that is considered to be correct. For some question items, multiple correct responses may be entered by the author. A degree of correctness (e.g. 100%, 75%, 50% etc.) may be specified for each response.

[0056] As still another aspect of authoring the question item, the author may optionally also specify whether feedback is to be provided to the user during the use stage (**218**) and, if so, the substance of the feedback. Feedback may be made available automatically to the user after the user has provided a response to a question item, or e.g. by way of a "feedback" button that appears after the response has been provided, which displays feedback upon selection by the user. The author-specified feedback is typically textual and explains why a selected answer is correct or incorrect. Feedback may for example be provided for each different foil of a multiple choice question item. Time spent viewing feedback for a question item usually is recorded but does not count towards completion time for that question item, although this too may be author-controlled.

[0057] All of the above-noted author input pertaining to the question item, i.e. P, Q and R components, display mode, completion time determination criteria, minimum and/or maximum completion times, hint information, correct answer(s) and feedback, is stored in memory for each question item (**220**). In the result, a record for the question item (or "question item record") is created and stored within memory. If the electronic learning curriculum is being created locally at authoring workstation **12**, the record will be stored in memory at the authoring workstation **12**. If the electronic learning curriculum is being created at curriculum server **16** under the control of the author from authoring workstation **12**, then the record will be stored at curriculum server **16**. An exemplary record is illustrated in FIG. **4**.

[0058] Referring to FIG. **4**, it can be seen that record **400** includes a field for each of the aspects of the question item for which the author has provided input. Thus, the record **400** includes a subject matter field **402** representing the P component (which may store text, an image, a video clip, an audio clip, or virtually any other form of subject matter), a query/instruction field **404** representing the Q component, a response mechanism field **406** representing the R component, a display mode field **408** representing one of the eighteen above-described display modes for the illustrated embodiment, a completion time determination criteria field **410** storing information as to which of the P, Q and/or R presentation durations are to be used in determining completion time, a minimum and/or maximum completion times field **412**, a hint information field **414** including hints for the P, Q and/or R components, a correct response(s) field **416**, and a feedback information field **418**. It will be appreciated that response mechanism field **406** does not necessarily store a response mechanism per se (e.g. a multiple choice response with selectable foils or an editable text field), but rather may store a representation of the response mechanism that should be presented during the use stage (e.g. a representation of each foil of a multiple choice response, an indicator that an editable text field should be displayed, etc.). Additional fields (not expressly shown) may be provided. The record **400** may for example be a conventional database record.

[0059] Additional question items are composed in the manner shown in FIG. **2**. These question items are then used to create a curriculum, as shown in FIGS. **5** and **6**.

[0060] Referring to FIG. **5**, operation **500** for creating a curriculum is illustrated. Initially, the author groups multiple question items into question item sets (**502**). A question item set is a set of question items (**1** to n) that may be: (1) intended to be presented together during electronic learning in one or more sittings; (2) all related to specific topic; (3) all of a specific difficulty level; or (4) otherwise classified within the curriculum. The author repeats **502** to create one or more other question item sets (**504**) which collectively form the curriculum.

[0061] For example, referring to FIG. **6**, to create an electronic learning curriculum **600** pertaining to simple mathematics, an author may generate four question item sets **602**, **604**, **606** and **608** pertaining to addition, subtraction, multiplication and division, respectively. Each set may contain one hundred question items based on the one hundred different permutations of two-operand equations that are possible for single-digit operands 0-9 for the mathematical operation in question (e.g. for addition: 0+0=?; 0+1=?; . . . 0+9=?; 1+0=?; 1+1=?; . . . 9+8=?; 9+9=?). For each question item set, the author may stipulate whether the question items should be presented sequentially or in random order during the use stage. These elections may be stored as part of the electronic learning curriculum. The number of question items in each set may vary. In some embodiments, an electronic learning curriculum may contain only one question item set.

[0062] As a further aspect of authoring a curriculum, the author specifies three different skill score thresholds T1, T2 and T3 to be used during electronic learning (FIG. **5**, **506**). These thresholds dictate when a user of the curriculum has reached beginner, intermediate and expert levels of competency, respectively, for a particular question item set: when a

collective (e.g. average) user competency measure for the question item set meets or exceeds a threshold, that level of competency is considered to be attained. The thresholds T1-T3 may be specified on a per-set basis or curriculum-wide. The role of threshold T1, T2 and T3 will become apparent from the subsequent description of the curriculum advancement algorithm that is applied during the use stage.

[0063] All of the author-specified curriculum criteria, i.e. the groupings of question items into sets and the T1-T3 thresholds, are ultimately stored as part of the electronic learning curriculum (**508**).

[0064] Authoring of the curriculum is thus completed. The electronic learning curriculum may thereafter be transferred from the authoring workstation **12** to curriculum server **16**, e.g. as one or more electronic files, possibly compressed for efficient transmission over network **18** or encrypted for security.

Use Stage

[0065] To use the curriculum for electronic learning, a user interacting with a user workstation **14** accesses the curriculum server **16** over network **18**. Access may for example involve invocation of a web browser application at the user workstation **14**, navigating to a predetermined Uniform Resource Locator (URL) where the electronic learning curriculum is posted or maintained, and entry of user account information. The user account information may permit records of any past interaction with the electronic learning curriculum (e.g. previous completion of one or more question item sets or question item sets and past skill score values) to be accessed. A desired or current question item set is identified, e.g. based upon the user's progress to date through the electronic learning curriculum (as may be apparent from a graphical "dashboard" summary of user performance to date through the curriculum that may exist in some embodiments), impending test dates, manual selection by a user or other criteria. When the user has indicated a readiness to proceed, e.g. by pressing a "begin session" user interface button or the like, the user workstation **14** communicates with the curriculum server **16** to begin displaying the question items of the current question item set, question item by question item. The question items of each set are presented either in sequential or random order, as earlier specified by the author during the authoring stage.

[0066] Operation **700** for presenting the question items of a current question item set is illustrated in FIG. **7**. Based on the user's progress through the curriculum to date, a next question item is obtained (**702**). Typically, the next question item is sequentially or randomly drawn from the question items of a current set that are as-yet unanswered. The question item is retrieved from a data store, which may comprise volatile or non-volatile memory. The P, Q and R components of the question item (i.e. the subject matter, query/instruction and response mechanism) are then presented at user workstation **14** in a presentation sequence. As earlier described, the presentation sequence for these components in the present embodiment comprises:

[0067] (i) presenting one of P and Q; then

[0068] (ii) presenting the other of P and Q; then

[0069] (iii) presenting R.

Each of (i), (ii) and (iii) may be referred to as a "stage" in the presentation sequence. The specific sequence (i.e. which of P or Q is first) determined by the display mode is specified by the author during the authoring stage (**704**). Any requested hints or help (if available) are also displayed.

[0070] When the display mode specifies consecutive presentation of the question item components in stages (i) and (ii) (i.e. when the display mode incorporates "P:Q", "P|Q", "Q:P" or "Q|P"), then whichever one of P or Q is presented in stage (i) is replaced by the other of P and Q that is presented in stage (ii) upon user advancement from stage (i) to stage (ii).

[0071] For display modes permitting review of the component presented in stage (i) (i.e. incorporating "P:Q" or "Q:P"), stage (i) may later be repeated upon user request (although not necessarily for the same duration as it was originally presented). The duration of the repeated stage (i) (i.e. the duration of review) may optionally be stored separately from the initial presentation duration of stage (i), even if both durations shall contribute to (e.g. are summed for the purpose of determining) the presentation duration for the question item component that is presented in stage (i), as described below.

[0072] Similarly, when the display mode specifies consecutive presentation of the question item components in stages (ii) and (iii) (i.e. when the display mode incorporates "Q:R", "Q|R", "P:R" or "P|R"), then whichever one of P or Q is presented in stage (ii) is replaced by R upon advancement from stage (ii) to stage (iii). For display modes permitting review of the component presented in stage (ii) (i.e. incorporating "Q:R" or "P:R"), the presenting of stage (ii) may be repeated upon user request (although not necessarily for the same duration as it was originally presented). The duration of the repeated stage (ii) (i.e. the duration of review of whatever was presented in stage (ii)) may optionally be stored separately from the initial presentation duration of stage (ii), even if both durations contribute to (e.g. are summed for the purpose of determining) the presentation duration for the question item component that is presented in stage (ii), as described below.

[0073] The presentation duration of each of P, Q and R is determined by the user-controlled progression through stages (i), (ii) and (iii). Stage (i) commences with user selection of a "start" button or similar GUI control which causes the first component be presented (although, in some embodiments, the presenting of stage (i) may commence automatically, e.g. after the preceding question item is completed or, e.g. after a countdown: "Next question in 3 . . . 2 . . . 1 . . . 0 seconds". Stage (i) ends upon user selection of a "next" button or similar GUI control. Likewise, stage (ii) commences upon user selection of the "next" button and ends with user selection of another "next" button or similar GUI control. Finally, stage (iii) commences upon user selection of the second "next" button and ends upon entry of a user response. In some embodiments, entry of a user response constitutes selection of a multiple choice foil or the typing of an answer into an editable text field. In other embodiments, entry of a user response may require user selection of a "submit" button or similar GUI control after specification of a response, or possibly manipulation of an external or peripheral device described above. Based on these start and end events, the durations of stages (i), (ii) and (iii) may be measured.

[0074] As previously noted, if P and/or Q components are "temporal" in nature, e.g. are audio or video clips or animations, they may be presented with a set of controls (e.g. play, pause, rewind, fast forward, or go to beginning) that may permit the user to manipulate the audio/video, including playing it more than once or stopping it before completion, if desired.

[0075] If the user reviews P and/or Q for display modes permitting such review, then the time spent reviewing is typically added to the initial presentation duration of the relevant question item component. For example, any time spent by the user viewing/listening to the P component for the first time will certainly contribute to presentation duration of the P component, but any time spent by the user reviewing the P component after the Q and/or R component have replaced P can also, at the author's election, be deemed to contribute to the presentation duration of P. The presentation duration of review may be separately stored from the presentation duration of initial display, e.g. for possible later use in the computation of metrics pertaining to user review times. Similarly, time spent reading hints or help for a question item component may contribute to the presentation duration of that component and may be separately stored.

[0076] The manner of ascertaining the presentation durations of the P, Q and R components for a question item may depend upon the operative display mode. For example, referring to FIG. **8**A, a timeline **800** showing measurement of presentation durations (here, in seconds) of P, Q and R during a user's interaction with a question item having a display mode of PIQIR is illustrated. The actions of the user in interacting with the question item's components during their presentation are indicated above the timeline **800**; the curved arrows **802**, **804** and **806** represent stages (i), (ii) and (iii) of the presentation sequence, respectively.

[0077] At t=0 (FIG. **8**A), the first question item component (P) is presented, e.g. in response to user selection of a "start" button. From t=0 to t=50, the user views the presented P component (for this example, it is assumed that P is a textual or visual component and is thus "viewed"). At t=50, user input, e.g. selection of a "next" button, causes P to be replaced with Q. From t=50 to t=65, the user reads the Q component. At t=50, user input, e.g. selection of another "next" button, causes Q to be replaced with R. From t=65 to t=77, the user reads the foils of the R component, i.e. the possible multiple choice answers and considers which response is correct (the question items of FIGS. **8**A to **8**C are all assumed to have multiple choice R components). Finally, at time t=77, the user completes response entry, e.g. by pressing a "submit" button after having selected a foil. Thus, the stages (i), (ii) and (iii) represented by arrows **802**, **804** and **806** correspond to the presentation durations for P, Q and R, respectively, which are therefore 50 seconds, 15 seconds and 12 seconds long.

[0078] In FIG. **8**B, which adopts similar conventions to FIG. **8**A, the effect of user review of the first displayed question item component (i.e. repetition of stage (i)) upon presentation duration calculation is shown. FIG. **8**B may best be understood when viewed in conjunction with FIG. **3**B, which illustrates the stages of displaying a question item for display mode P:Q:R. At t=0, the first question item component (P) is presented. At t=50, the user advances from the P component to the Q component (as per FIG. **3**B, **309**), e.g., by selecting the "next" button. At t=65, the user reverts to the P component (as per FIG. **3**B, **308**) e.g. by selecting a "review" button. At t=125, the user again advances to the Q component (as per FIG. **3**B, **309**). At t=132, the user advances to the R component (as per FIG. **3**B, **313**). Finally, at t=157, the user enters a response, e.g. by selecting a "submit" button or pressing "enter" after selecting a foil.

[0079] It will be appreciated that, in the example of FIG. **8**B, the P component presentation duration includes both the time spent initially viewing the component and any time spent reviewing the component. Thus, the P component presentation duration is determined by summing the time intervals **812** and **816**, i.e. 50 seconds plus 60 seconds, for a total of 110 seconds. The Q component presentation duration is similarly determined by summing the time intervals **814** and **818**, i.e. 15 seconds plus 7 seconds, for a total of 22 seconds (the interval **818**, which represents the second time Q is presented, is not considered "review" of Q per se as it merely results from the user's review of P during interval **816**; thus both of intervals **814** and **818** are labeled stage (ii) in FIG. **8**B). There is no review of the R component, thus the R component presentation duration simply corresponds to time interval **820** (i.e. stage (iii)), which is 25 seconds.

[0080] FIGS. **8**A and **8**B illustrate consecutive display of P, Q and R (the former without review and the latter with review). FIG. **8**C, on the other hand, illustrates cumulative presentation of P, Q and R.

[0081] Turning to FIG. **8**C, the measurement of presentation durations for P, Q and R in display mode P.Q.R is illustrated. In this display mode, the user workstation **14** detects when the user advances from the P component to the Q component (at time t=50) and from the Q component to the R component (at time t=132) as well as when entry of a response is complete (t=157). The presentation duration of the P question item component can be determined in one of two ways. The first way is to measure the totality of time that P is presented, regardless of when the subsequent question item component is later presented. Using this approach, the presentation duration for P would be the sum of the time intervals **842**, **844** and **846**, i.e. 157 seconds. The second way is to measure the time that P is presented until the next question item component appears (i.e. the time between the onset of the earlier-displayed question item component and the onset of the subsequent question item component, which in this example is Q). In the second approach, the presentation duration for each component reflects the time that the user's attention was likely focused upon that component.

[0082] The presentation durations of each of the P, Q and R components are determined as distinct values, and an indicator of each said distinct value (e.g. an elapsed time or one or more time stamps indicative of the presentation duration) is stored (FIG. **7**, **706**). This is so that, regardless of which of these components' presentation durations has been specified during authoring to comprise the completion time for the question item, if it is later desired to change the presentation duration(s) comprising the completion time, the necessary data for doing so is available (even after the user has completed electronic learning). For example, even after a question item of a set has been deemed to have been learned by a student based on the student's accurate response to that question item within an "acceptable" first completion time that was based solely on the presentation duration of R (i.e. how quickly the student entered a response), the student's user competency for that question item may later be reassessed, e.g. by an administrator of the electronic learning curriculum. This may be done by using the student's presentation duration for P, as previously stored, as the "new" significant completion time for that question item. A relative completion time for that question item and student may thereafter be determined, e.g. based on different minimum and/or maximum completion times which account for P rather than R being the significant presentation duration. Based on this "new" relative completion time and the previously stored response accuracy, a second user competency measure for the same question item

could be calculated and stored, possibly in addition to the first user competency measure. The second competency measure would reflect how quickly the student viewed/listened to P, rather than how long the student took to enter a response as in the first user competency measure. In **706**, the presentation duration of any displayed hints and/or help may also be determined and stored.

[0083] For accuracy, the presentation durations are measured at the user workstation **14** (e.g. using a system clock of the computing device, which is typically driven by an oscillator crystal), rather than at the curriculum server **16**. This is to avoid inaccuracies which may result from such factors as network propagation delays over network **18** for example. To minimize potential inaccuracies the user workstation **14** may avoid running other concurrent applications in the background. Further, in cases where timing accuracy is critical (e.g. real-time brain scan responses or the like), the user workstation **14** could use specialized hardware and/or execute a real-time operating system to maximize timing accuracy.

[0084] It is noted that, when P comprises a recording of auditory subject matter having a fixed duration of, say, 20 seconds, the presentation duration of P may be measured in various ways. If user input for advancing to the next question item component is received prior to the complete playing of the recording (e.g. at 18 seconds), the presentation duration for P may be set to the duration that had elapsed when the user input was received (i.e. 18 seconds). If user input for advancing to the next question item component is received some time after the recording has been fully played (e.g. at 23 seconds), the presentation duration for P may be set either to the duration that had elapsed when the user input was received (i.e. 23 seconds) or to the fixed recording duration (i.e. 20 seconds). If the user has manipulated controls to cause the audio to be played twice (i.e. 40 seconds) over the course of a 45 second duration, the duration may be set to 40 or 45 seconds. Various alternatives are possible.

[0085] Whatever display mode is operative, ultimately the user provides a response to the question item using whatever response mechanism has been specified for the question item (multiple choice, fill in the blank, etc.) using some user input mechanism (e.g. mouse, keyboard, peripheral controller, etc, as described above). This response is received (FIG. **7**, **708**) and stored, along with indicators of the presentation durations of the P, Q and R components (**710**) and a computed completion time for the question item that is based on one or more of the measured presentation durations for the P, Q and R components (equal to, e.g., one of the presentation durations, a sum of two of the presentation durations, or a sum of all three of the presentation durations, as specified by the author during the authoring stage). Thereafter, a user competency measure for the question item, which is alternatively referred to herein as a skill score, is computed and stored (**712**). Skill score computation is based on the user's performance over a number of trials in which the same question is presented at least one, but typically more than once, and is described in greater detail below in conjunction with FIG. **9**. If any unanswered question items in the set remain (FIG. **7**, **714**), the process is repeated.

[0086] Operation **900** for computing a skill score for a current trial, as in block **712** of FIG. **7**, is illustrated in FIG. **9**. Initially, a response accuracy for the current trial is determined based on the user response and at least one predetermined correct response, and is stored (FIG. **9**, **902**). In the present embodiment, the response accuracy is a value in the range of zero to one (or 0% to 100%), where zero represents an incorrect user response, one represents a correct user response, and values between zero and one indicate partially correct responses.

[0087] Thereafter, a completion time for the current trial is determined (**904**). The completion time is based on the measured presentation duration(s) of whichever one(s) of the P, Q and/or R question item components have been specified by the author (at FIG. **2**, **210**) as comprising the completion time for this question item. For example, if the author had specified that the presentation duration of just the Q and R components (representing the time spent by the user in viewing the query/instruction and viewing the response mechanism/entering a response) are to be used for determining completion time for this question item, then completion time is determined in **904** by summing the user's measured Q and R presentation durations, with any time spent reviewing the Q component (if applicable) or reviewing hints or help for either of the Q or R components (if applicable) optionally forming part of the presentation durations for these question item components, at the author's discretion.

[0088] Next, an average response accuracy (RAavg) for the question item is determined based on the response accuracies S trials in which the same question item has been presented to the user (FIG. **9**, **906**), where S is a positive integer. The average response accuracy thus takes into account the user's accuracy in answering the same question item over a window of S attempts.

[0089] In the present embodiment, the calculation of an average response accuracy entails calculating a weighted average of S stored response accuracies. In other words, it is presumed that the user has been presented with the same question item S times, and each time the user's response and completion time was stored for later use in computing the skill score for that question item. For example, TABLE 2 below represents stores data associated with the five trials of responding to an exemplary question item, i.e. question item

[0090] In TABLE 2, each trial for question item 1 is represented by a table row. The first row represents the least recent trial and the last row represents the most recent trial. The values in the second column indicate the correctness of the user response for each trial. The response accuracies in the third column are equal to one for a correct response and zero for an incorrect response. The weights in column four represent the relative weight of each response and completion time for the trial represented by the row in relation to the trials represented by other rows. The values in column five represent the completion times for each trial.

TABLE 2

S Trials of Completing Question Item 1 (S = 5)

TRIAL NO.	CORRECT?	RESPONSE ACCURACY	WEIGHT	COMPLETION TIME
1	Yes	1	1	3.4 seconds
2	No	0	2	1.1 seconds
3	Yes	1	3	3.0 seconds
4	Yes	1	4	2.6 seconds
5	No	0	5	5.6 seconds

[0091] In the present embodiment, the calculation of an average response accuracy for a question item comprises calculating a weighted average. More specifically, each

response accuracy (column 3) is weighted by its corresponding weight (column 4) and the resulting weighted accuracies are summed. For the data of TABLE 2 above, this would entail performing the following calculation: 1*1+0*2+1*3+1*4+0*5=8. This sum of weighted accuracies is then divided by a sum of weighted accuracies that would result for S correct responses, i.e. 1*1+1*2+1*3+1*4+1*5=15. The resulting average response accuracy is 8/15 or 0.533.

[0092] In some embodiments, the average response accuracy may be a straight (i.e. non-weighted) average of actual response accuracies in relation to the accuracies that would result for S correct responses, i.e. (1+0+1+1+0)/(1+1+1+1+1) or 0.600. It is understood that the term "average" as used herein may encompass other types of calculations for assessing a representative measure of completion time based on S trials, such as calculating a median.

[0093] Subsequently, an average completion time (CTavg) for the question item is determined based on the completion times of only the ones of those S trials in which a correct user response was given (FIG. **9**, **908**). The average completion time of the present embodiment is computed as a weighted average. More specifically, each completion time (column 5) for a trial in which a correct response was given (i.e. for rows 1, 3 and 4 but not rows 2 or 5) is weighted by its corresponding weight (column 4), and the resulting weighted completion times are summed. For the data of TABLE 2 above, this would entail performing the following calculation: 3.4 sec*1+3.0 sec*3+2.6 sec*4=22.8 seconds. This sum is then divided by a sum of the weights for the trials in which a correct response was given, i.e. 1+3+4=8. The resulting average completion time is 22.8 seconds/8 or 2.85 seconds.

[0094] In some embodiments, the average completion time may be a straight average of the completion times of the last S attempts for which correct responses were given, i.e. (3.4 sec+3.0 sec+2.6 sec)/3 or 3.00 seconds. It is understood that the term "average" as used herein may encompass other types of calculations for assessing a representative measure of completion time based on S trials, such as calculating a median.

[0095] Thereafter, a relative average completion time (CTrelavg) for the current trial is calculated (FIG. **9**, **910**). This essentially involves comparing the average completion time (CTavg) computed above to the minimum completion time (CTmin) and/or maximum completion time (CTmax) for the question item, as specified by the author during the authoring stage. In the present embodiment, relative completion time is calculated based on both CTmin and CTmax, according to equation (I) below:

$$CTrelavg=((CTmax-CTavg)/(CTmax-CTmin))^{p}$$

[0096] That is, the difference between the maximum completion time and the average completion time, as determined in block **908**, is divided by the difference between the maximum and minimum completion times, and the resulting value is exponentiated, i.e. raised to an exponent p, where p is a number greater than zero. The exponent serves to differentially weight speed improvements as the user gets faster with training. When p is greater than one, the choice of a value for the exponent p allows the author to selectively weight those times that are closer to CTmin more heavily than those that are closer to CTmax. The larger the exponent, the heavier the weighting. For example, as between two embodiments in which p=3 and p=5 respectively, the latter would require a user to get much closer to the minimum completion time (i.e. expert speed) before increase in speed is evidenced in user competency measure improvements. When p is between 0 and 1, on the other hand, improvements near CTmax (i.e. beginner speeds) are weighted more heavily than those near CTmin. The value of CTrelavg resulting from the exponentiation ranges from zero to one in the present embodiment, with zero representing a user completion time equal to the maximum response time and one representing a user completion time equal to the minimum response time. Thus, the faster the user's completion time, the greater the relative completion time value as computed by equation (I).

[0097] When the average completion time is smaller than the minimum completion time it may be increased to match the minimum completion time. Similarly, when average completion time is larger than the maximum completion time, it may be reduced to match the maximum completion time. This may avoid negative values in the base of the exponent for equations above which could result in undesirable negative CTrelavg values for certain values of P.

[0098] In equation (I) above, relative average completion time is based on the average completion time as well as both of the author-specified minimum and maximum completion times CTmin and CTmax. In alternative embodiments, the relative average completion time may be based on the average completion time and only one or the other (not both) of CTmin and CTmax. Two alternative equations (I') and (I") for calculating relative completion time in such a fashion are provided below.

$$CTrelavg=(CTmin/CTavg)^{p} \quad (I')$$

$$CTrelavg=(1-(CTavg/CTmax))^{p} \quad (I")$$

[0099] In some embodiments, the equation that is used to convert completion time to a number from 0 to 1 may differ from equations (I), (I') and (I") above. For instance, in some embodiments, it may be acceptable for the function to be linear rather than exponential. The conversion could also by done by one or more tables.

[0100] Thereafter, an overall skill score for the current trial is computed (FIG. **9**, **912**). In the present embodiment, this is achieved by way of equation (II), as specified below:

$$\text{Skill Score} = RAavg * C1 + CTrelavg * C2 \quad (II)$$
$$= X + Y$$

[0101] In equation (II), the average response accuracy is scaled by a constant C1 (i.e. scalar C1) and relative average completion time is scaled by a constant C2 (i.e. scalar C2). The scaled results may be referred to as the "X" and "Y" components of the skill score, respectively. The X and Y values are summed to yield the overall skill score. Scaling the accuracy and relative completion time values may have two benefits. Firstly, it may give the score greater relevance to a typical user. For example, the skill score of the present embodiment ranges between zero (for a completely incorrect response answered in the maximum amount of time) and two (for a 100% correct response answered in the minimum amount of time). However, by choosing constants C1 and C2 that sum to 1000 (in which case a perfect skill score would be 1000), the skill score may be made resonate with certain users as comparable to a baseball batting average. Secondly, scaling may allow the relative importance of accuracy versus

relative completion time to be set by the author. For example, by setting C1 to 900 and C2 to 100, the skill score may be weighted much more heavily towards accuracy of response than towards speed of response. Any desired weighting may thus be attained by the author. Once computed, the skill score is stored (**910**).

[0102] FIG. **10** contains a table **1000** illustrating exemplary skill scores as may be computed by equation (II) above for various user response accuracy and completion time scenarios. The table **1000** includes a body **1002** of four hundred twenty cells (twenty one rows by twenty columns). Each cell within the body **1002** contains a skill score that would result, based on equation (II), for a unique user response accuracy and completion time scenario, with exemplary C1 and C2 values of 500 being assumed.

[0103] In FIG. **10**, the average response accuracy associated with a particular cell is indicated in column **1004**, in the row occupied by that cell. Similarly, average completion time associated with a particular cell is indicated in row **1006**, in the column occupied by that cell. For example, cell **1008** within body **1002** represent the skill score that results when the user responds 95% accurately (**1010**) with an average completion time of 1 second (**1012**).

[0104] Column **1004** contains response accuracies ranging from 100% to 0%, at 5% intervals. The corresponding X values that would be generated according to equation II (i.e. average response accuracy scaled by the exemplary C1 value of 500) are shown in column **1014**. Row **1006** shows completion times ranging from 0 seconds (the minimum completion time) to 20 seconds (the maximum completion time) at one second intervals. The corresponding Y values that would be generated according to equation II (i.e. relative average completion time scaled by the exemplary C2 value of 500) are shown in column **1016**. It will be appreciated that the skill score value in any cell of body **1002** represents the sum of the X value from column **1014** in the column occupied by that cell and the Y value from row **1016** in the column occupied by that cell. A perfect skill score of 1000 (100% correct response in the minimum time of zero seconds) is shown in the upper left hand corner of body **1002**, while a minimum skill score of 0 (0% correct response in the maximum time of twenty seconds) is shown in the lower right hand corner of body **1002**.

[0105] As earlier described, operation **700** of FIG. **7** represents a single pass by a user through a set of question items. However, it will be appreciated that multiple passes may be required in order for a user to be considered to have truly learned the curriculum. To guide the user from being a beginner to being an expert in a particular curriculum, a curriculum advancement algorithm is applied. This algorithm is exemplified by operation **1100** of FIG. **11**.

[0106] Referring to FIG. **11**, operation **1100** illustrates an exemplary algorithm for advancement of a user from a beginner skill level to an expert skill level for an exemplary electronic learning curriculum comprising multiple question item sets. Initially, a collective user competency measure, referred to herein as a collective skill score (CSS), is computed for each question item set within the curriculum (**1102**). A CSS is a value that reflects the user's competency across multiple question items. A CSS is typically computed by averaging the skill scores for all of the question items of the set. In some embodiments, calculating the CSS may involve combining the average skill score for the set (based on the user's most recent pass through the set) with one or more previously computed average skill scores for the set (based on the user's prior pass(es) through the set). Combining may entail weighting the most recent average more heavily that the previously computed average(s). Some embodiments could average the sets' speeds and accuracies separately.

[0107] If a question item set has not yet been presented to the user in accordance with operation **700** of FIG. **7**, then the CSS may initially have a default value of zero.

[0108] The collective skill scores computed for each question item set are then used to determine what set to present next. If the collective skill score for any set of the question item set is below a first threshold T1 (**1104**), where T1 is a threshold CSS value representing a "beginner" skill level, the set having the collective skill score closest to but below T1 is presented next (**1106**). The rationale for this approach, which may be referred to as the "race up" approach, is to prioritize question item sets whose collective skill are the highest but are not yet at threshold T1, so that each set has a baseline of exposure before more stringent thresholds must be met. In this case the user has at least a beginner level of competence in all of the sets before advancing further. The race up approach emphasizes breadth over depth. Once the question item set has been presented (**1106**), the CSS for the set is recomputed (**1108**). Assuming that the number of correct responses and/or completion times are better in this pass than they were during the user's last pass through the question item set, the CSS value will improve, possibly meeting or exceeding the threshold CSS value T1.

[0109] Operation then repeats from 1104. It will be appreciated that, if the CSS value for the presented set has not yet met or exceeded T1, it may be presented again (assuming that its CSS remains the CSS value that is closest to but below T1) upon repetition of 1106.

[0110] Ultimately, when the CSS values for each question item set meets or exceeds the threshold CSS value T1, the user is considered to have attained a "beginner" skill level for the question item set as a whole. Operation then advances to **1110**.

[0111] At **1110**, if the collective skill score for any question item set is below a second threshold CSS value T2, where T2 is a threshold CSS value representative of an "intermediate" skill level, the set having the lowest collective skill score of all sets in the question item set is presented next (**1112**). The rationale for this approach, which may be referred to as the "bubble up" approach (since, as the set with the lowest CSS improves and exceeds another set's CSS, its CSS will not improve further until the set with the new lowest CSS improves and exceeds another set's CSS), is to prioritize question item sets whose collective skill are the lowest despite being at least T1. The rationale is to ensure that all sets are learned at a predetermined level before attention is given to the weakest items across the sets. Once the question item set has been presented (**1112**), the CSS for the set is recomputed (**1114**). Assuming that the number of correct responses and/or completion times are better than they were during the user's last pass through the question item set, the CSS value will improve, possibly meeting or exceeding the threshold CSS value T2. Bubble up may suit learning environments in which a user may alternate learning among many sets, possibly allowing the user to perceive interconnections and relations among question items across the set topic context.

[0112] Operation then repeats from **1104**. The reason that operation repeats from **1104** rather than from **1110** is to account for the possibility that the CSS for a question item set

which previously met or exceeded T1 could drop below T1, requiring operation at **1106-1108** to be repeated.

[0113] Upon repetition of **1112**, it will be appreciated that, if the CSS value for a previously presented set has not yet met or exceeded T2, it may be presented again (assuming that its CSS remains the lowest CSS value of all sets in the curriculum while still exceeding T1). Ultimately, when the CSS values for each question item set meets or exceeds the threshold CSS value T2, the user is considered to have attained an "intermediate" skill level for the curriculum as a whole. Operation advances to **1116**.

[0114] At this stage, individual question items whose skill scores are the weakest (regardless of set) are presented, along with some "maintenance question items" (i.e. randomly selected question items being repeated simply to maintain an existing level of user competency) mixed in, until a third threshold T3 is reached for each set, where T3 is a CSS value representative of an "expert" skill level. The curriculum is then considered to have been learned. To promote revisiting of all question items, the maintenance question items could be chosen based on date last tested, with the least recent being chosen first. The oldest items are more likely to be forgotten and therefore should be randomly sampled more often.

[0115] More specifically, at **1116**, if the collective skill score for any question item set is below the third threshold value T3, N individual question items (where N is a positive integer) whose skill scores are the lowest are identified (**1118**). The N question items are selected regardless of whether they belong to a set whose CSS is less than T3 or greater than or equal to T3. The rationale for this approach is to focus on question items for which the user has demonstrated the least user competency, with any improvements in user competency for those question items resulting in an improvement in user competency for the question item sets to which they belong. M maintenance question items (where M is a positive integer different from or the same as N) are also selected (**1120**). The N question items identified in **1118** are then presented along with the M question items selected in **1120** (**1122**). When this has been done, the CSS for all sets from which at least one of the N or M question items was drawn is recomputed (**1124**).

[0116] Operation then repeats from **1104**. The reason that operation repeats from **1104** rather than from **1116** is to account for the possibility that the CSS for a question item set which previously met or exceeded T1 could theoretically drop below T1 or T2, requiring operation at **1106-1108** or **1112-1114** to be repeated.

[0117] Ultimately, when the CSS values for each question item set meets or exceeds the threshold value T3, the user is considered to have attained an "expert" skill level for the curriculum as a whole. Operation **1100** is thus completed.

[0118] FIG. **12** contains a table **1200** illustrating advancement of a user from a beginner skill level to an expert skill level according to algorithm 1100. In FIG. **12**, advancement is shown for four exemplary electronic learning curricula 1-4, each comprising four question item sets (1a-1d, 2a-2d, 3a-3d, and 4a-4d, respectively). Each row in the table **1200** represents a distinct user session at user workstation **14**, while each column in the table represents a question item set. A session is a single work period in which the user completes one or more sets of question items. It may be alternatively be thought of as the work accomplished in a single login period. The user's progress from an initial session s0 to a final session s25 is shown, with the algorithm illustrated in FIG. **11** being applied once for each of the electronic curricula, in sequence.

[0119] Each cell within table **1200** contains a collective skill score (CSS) value for the relevant question item set indicated by the containing column at the completion of the relevant session indicated by the containing row. In table **1200**, cells containing a bolded CSS value indicate that the CSS value has changed from the previous session above. For the purposes of FIG. **12**, it is assumed that T1=400, T2=600 and T3=800.

[0120] Beginning with session s0, which represents an initial assessment of the user's competency, collective skill score values of 0 are set for each of the sixteen question item sets, reflecting an initial assumption of a complete lack of user competency in the relevant curricula.

[0121] Beginning with curriculum 1, in a first session s1, the user completes each of the four contained question item sets 1a-1d once, with the resulting CSS values for each question item set being shown in bold in the relevant row of table **1200**. In view of the fact that the resulting CSS values exceed threshold T2 for each set 1a-1d but are less than T3 for at least one of the sets, operation **1100** proceeds directly to **1116** (FIG. **11**) in the next session s2. In this example, it is assumed that the N weakest question items and M maintenance question items are drawn from each of the four sets 1a-1d. When operation **1118** to **1124** of FIG. **11** is performed, the CSS for three of the four question item sets increase. However, because they remain below threshold T3, operation **1116** to **1124** is repeated in session s3. In this pass, all of the CSS values exceed T3, and the first curriculum is therefore considered to have been learned.

[0122] Turning to curriculum 2, in session s4 the user completes each of the four contained question item sets 2a-2d once, with the resulting CSS values for each question item set being shown in bold in the relevant row. In view of the fact the resulting CSS values for sets 2c and 2d are below threshold T1, operation **1100** proceeds to **1106** in the next session s5. Set 2c is identified as the set whose CSS is closest to but below T1, so it is presented (**1106**) and its CSS recomputed (**1108**) to a value **410**, which exceeds T1. Accordingly, in the next session s6, the only set 2d whose CSS remains below T1 is presented (**1106**) and its CSS recomputed (**1108**) to a value **480**.

[0123] Now that that the CSS values for all sets 2a-2d exceeds T1, operation proceeds to **1110**. Because set 2c has the lowest CSS value of 410, it is presented (**1112**) and its CSS recomputed (**1114**) to a value **590** in session s7. Because set 2d now has the lowest CSS value of 480, it is presented (**1112**) next and its CSS recomputed (**1114**) to a value **630** in session s8. Operation **1110-1112** is repeated for set 2c in session s9, given that it is the only remaining set with a CSS below T2. The resulting CSS of 670 exceeds T2.

[0124] At this stage operation **1116-1124** is repeated three times in sessions s10 to s12, until all of the CSS values exceed T3. At that stage, the second curriculum is considered to have been learned.

[0125] From the foregoing, it will be apparent that the same approach is used for advancing curriculum 3 from beginner through to expert level in sessions s13 to s20 and for advancing curriculum 4 from beginner through to expert level in sessions s21 to s25.

[0126] As will be appreciated by those skilled in the art, various modifications can be made to the above-described embodiments. For example, in the above description, the

curriculum advancement algorithm is applied question item set by question item set, wherein the sets form part of an electronic learning curriculum. It will be appreciated that the curriculum advancement algorithm could be applied to any plurality of question items. For example, question item sets could be subdivided in to subsets, and the algorithm could be applied subset by subset.

[0127] It will also be appreciated that the operation illustrated in FIG. **11** at **1106-1108** (the "race up" approach) could be swapped for the operation described at **1112-1114** (the "bubble up" approach) in some embodiments. Alternatively, in some embodiments any of the "race up", "bubble up" and "mastery" approaches could be applied entirely independently of the others. Such embodiments may have only one operative CSS threshold.

[0128] In some embodiments, the "mastery" approach illustrated at **1118-1124** of FIG. **11** may be applied on a per-set basis, e.g. when a particular set's CSS has exceeded T2 but is still below T3, rather than across an electronic learning curriculum only when the CSS for all sets has exceeded T2. In that case, the pool of question items from which question items are drawn may be limited to that set.

[0129] In some embodiments, the threshold values T1, T2 and/or T3 used during operation **1100** may be dynamically adjustable between iterations of the curriculum advancement algorithm. For example, once the user has advanced to an expert level based on initial threshold values of, say, T1=400, T2=600 and T3=800, the user may be required to repeat operation **1100** with T1=500, T2=750 and T3=950. Alternatively, the higher threshold values may be set prior to user completion of operation **1100**, based on a favorable initial assessment of user competency for example.

[0130] In some embodiments, after completion of operation **1100** for two (or more) question item sets, the sets may be combined to create a new, larger set, and operation **1100** may be repeated for that new set, possibly with higher threshold values.

[0131] To expedite operation **1100**, the CSS for a question item set may be recomputed after each question item is completed, rather than just after all question items have been completed (as at **1108**, **1114** and **1124** of FIG. **11**), with the user being permitted to advance to the next competency level or complete the question item set immediately upon meeting or exceeding the operative CSS threshold for the current competency level. This may avoid user frustration in having to repeat all of the question items of a set every time the set is presented.

[0132] In some embodiments, the software application by which the electronic learning curriculum is authored at the workstation **12** may simply be a web browser application which presents authoring software that is actually hosted by a web server comprising curriculum server **16**. In such embodiments, although authoring of the electronic learning curriculum is still controlled by the author, the actual curriculum may be created at the curriculum server **16** based on remote author instructions from authoring workstation **12**. In that case, uploading of the curriculum after the authoring stage may be unnecessary, since the curriculum may already be situated at the curriculum server **16**, within a data store.

[0133] It will be appreciated that implementation of any aspect of the above-described system in "software" could be effected in firmware or hardware, or using combination of software, firmware and/or hardware.

[0134] In some embodiments, a user of an electronic learning curriculum may be able to revisit a previously answered question item within a set of question items, e.g., through selection.

[0135] The response accuracy for computing a skill score will usually be 0 or 1 on a single trial (unless partial credit marks are specified by the author as being available), but as question item sets are repeated the accuracy component can effectively become a weighted average of the last n trials in some embodiments. In such embodiments, values between 0% and 100% represent partially leaned items. For example, responding correctly on the last time may be worth a weight of 4, on the second to last time may be worth a weight of 3, third to last time may be worth a weight of 2, and fourth to last may be worth a weight of 1. This is based on memory phenomena such as recency and forgetting.

[0136] In some embodiments, the X and Y components of equation (II) may be combined in ways other than summing. The skill score could also be a family of functions or tables, weighting the accuracy and speed components, e.g. user competency measure=accuracy*speed*1000. In one embodiment, historical data is averaged over the last n trials (where n is an integer, typically 4 to 10).

[0137] The number of display modes may vary in alternative embodiments. Some embodiments may not have display modes per se. For example, a fixed presentation sequence (e.g. P, Q, R) may be used for all question items.

[0138] In some embodiments, the number of thresholds used in a curriculum advancement algorithm may be less than or greater than three.

[0139] It should be appreciated that the software for authoring or using an electronic learning curriculum can be deployed in numerous ways. In one embodiment, a "Software as a Service" (SaaS) model is used, in which both workstations **12** and **14** may use a web browser or other application having a GUI for accessing and using software stored in the memory of the curriculum server **16**. In this approach, neither of workstations **12** or **14** has any dedicated software installed on the local hard drive per se. Alternatively, a dedicated authoring application may be installed on workstation **12**. A curriculum generated by such an application may be stored at server **16** and downloaded to the workstation **14** upon user request. There, the curriculum could be executed by a dedicated local application for presenting the curriculum.

[0140] In some embodiments, question items can include instructions, facts to be memorized, and non-evaluative material such as demographic data from surveys that have no correct answer. For some question items, there may be no "correct answer".

[0141] Other modifications will be apparent to those skilled in the art and, therefore, the invention is defined in the claims.

What is claimed is:

1. A machine-readable medium storing instructions for presenting a question item of an electronic learning curriculum, said instructions, when executed by a processor of a computing device, causing said computing device to:

(a) retrieve from a data store a question item comprising:
textual, visual or auditory subject matter;
a query or instruction pertaining to said subject matter; and
a representation of a response mechanism for receiving a user response to said query or instruction;

(b) present said subject matter, said query or instruction and said response mechanism in a presentation

sequence, wherein a presentation duration of each of said subject matter, said query or instruction and said response mechanism in said presentation sequence is controlled by user input;

(c) based on said user input, determine:

a presentation duration of said subject matter;

a presentation duration of said query or instruction; and

a presentation duration of said response mechanism; and

(d) store indicators of each of said three presentation durations.

2. The machine-readable medium of claim **1** wherein said presentation sequence comprises:

(i) presenting one of said subject matter and said query or instruction; then

(ii) presenting the other of said subject matter and said query or instruction; then

(iii) presenting said response mechanism.

3. The machine-readable medium of claim **2** wherein said instructions further cause said computing device to retrieve from said data store a display mode specific to said question item which determines said presentation sequence for said question item.

4. The machine-readable medium of claim **3** wherein said display mode requires the other of said subject matter and said query or instruction that is presented in (ii) to replace the one of said subject matter and said query or instruction that is presented in (i).

5. The machine-readable medium of claim **4** wherein said display mode precludes repeating (i) after (ii) prior to entry of a user response.

6. The machine-readable medium of claim **4** wherein said instructions further cause said computing device to repeat (i) after (ii) upon user request and to store a measured duration of the repeated (i).

7. The machine-readable medium of claim **3** wherein said display mode requires the response mechanism presented in (iii) to replace the other of said subject matter and said query or instruction presented in (ii).

8. The machine-readable medium of claim **7** wherein said display mode precludes repeating (i) or (ii) after (iii) prior to entry of a user response.

9. The machine-readable medium of claim **7** said instructions further cause said computing device to repeat (i) or (ii) after (iii) upon user request and to store a measured duration of the repeated (i) or (ii).

10. The machine-readable medium of claim **3** wherein said display mode requires the other of said subject matter and said query or instruction that is presented in (ii) to be presented cumulatively with the one of said subject matter and said query or instruction that is presented in (i).

11. The machine-readable medium of claim **10** wherein said determining of the presentation duration of the one of said subject matter and said query or instruction that is presented in (i) comprises either:

measuring a duration of (i) but not (ii); or

measuring a duration of both (i) and (ii).

12. The machine-readable medium of claim **3** wherein said display mode requires the response mechanism presented in (iii) to be presented cumulatively with the other of said subject matter and said query or instruction that is presented in (ii).

13. The machine-readable medium of claim **12** wherein said determining of the presentation duration of the other of said subject matter and said query or instruction that is presented in (ii) comprises either:

measuring a duration of (ii) but not (iii); or

measuring a duration of both (ii) and (iii).

14. The machine-readable medium of claim **1** wherein said instructions further cause said computing device to:

(e) receive a user response to said query or instruction via said response mechanism;

(f) ascertain a response accuracy based on said response and at least one predetermined correct response;

(g) determine a completion time for said question item based on one or more of said presentation duration of said subject matter, said presentation duration of said query or instruction and said presentation duration of said response mechanism; and

(h) store said response accuracy and said completion time for said current trial.

15. A computing device having a processor in communication with memory storing instructions for presenting a question item of an electronic learning curriculum which, when executed by said processor, cause said computing device to:

(a) retrieve from a data store a question item comprising:

textual, visual or auditory subject matter;

a query or instruction pertaining to said subject matter; and

a representation of a response mechanism for receiving a user response to said query or instruction;

(b) present said subject matter, said query or instruction and said response mechanism in a presentation sequence, wherein a presentation duration of each of said subject matter, said query or instruction and said response mechanism in said presentation sequence is controlled by user input;

(c) based on said user input, determine:

a presentation duration of said subject matter;

a presentation duration of said query or instruction; and

a presentation duration of said response mechanism; and

(d) store indicators of each of said three presentation durations.

16. The computing device claim **15** wherein said presentation sequence comprises:

(i) presenting one of said subject matter and said query or instruction; then

(ii) presenting the other of said subject matter and said query or instruction; then

(iii) presenting said response mechanism.

17. The computing device of claim **15** wherein said instructions further cause said computing device to:

(e) receive a user response to said query or instruction via said response mechanism;

(f) ascertain a response accuracy based on said response and at least one predetermined correct response;

(g) determine a completion time for said question item based on one or more of said presentation duration of said subject matter, said presentation duration of said query or instruction and said presentation duration of said response mechanism; and

(h) store said response accuracy and said completion time for said current trial.

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