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(54) **CHAT CARD ENGINE(S) FOR CONVERSATIONAL CHAT CARDS**

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(52) **U.S. Cl.**

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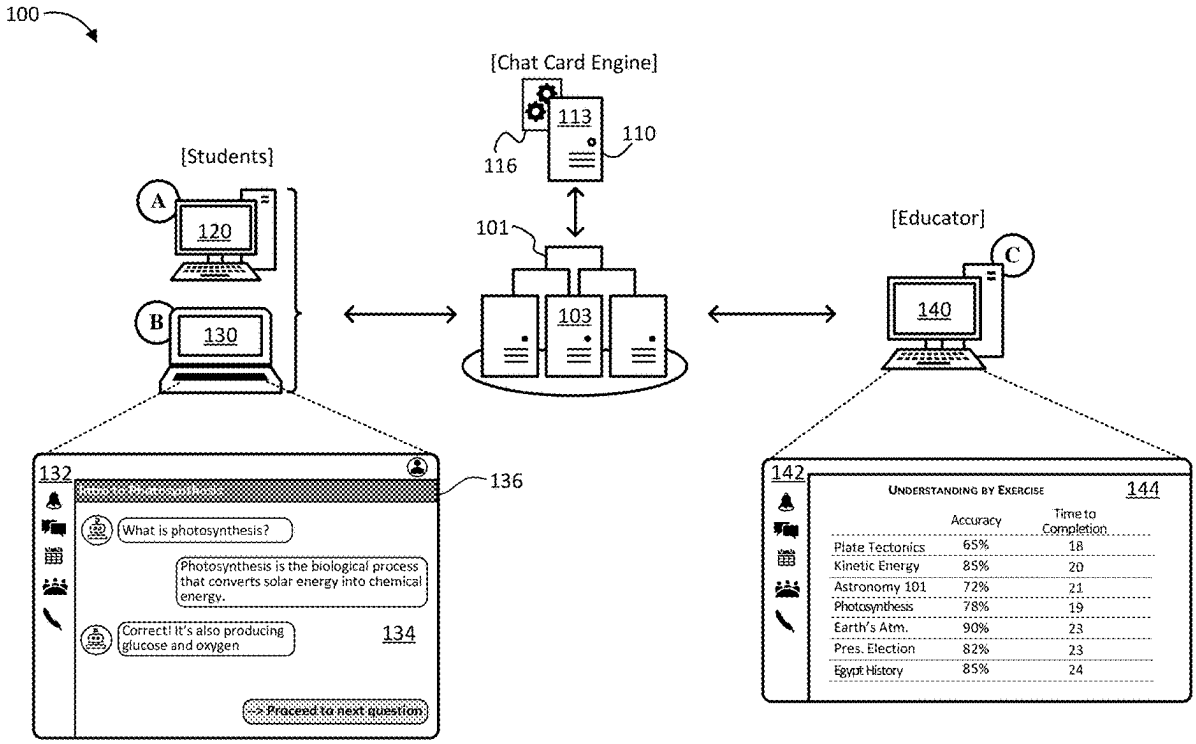
(57) **ABSTRACT**

Systems and methods for providing adaptive and conversational chat cards are provided herein. For example, a method may include receiving, from a client device, an indication to start a chat card exercise, determining, by a chat card engine, a source document based on the chat card exercise, and generating chat cards based on the source document. Each of the chat cards may correspond to a subtopic present in the source document. As such, the chat card engine may generate a first prompt based on a first subtopic and provide the first prompt within a first chat card to the client device. The chat card engine may receive a first query from the client device responsive to the first prompt and determine an understanding score. The chat card engine may then generate a second prompt based on the understanding score and provide the second prompt in the first chat card.



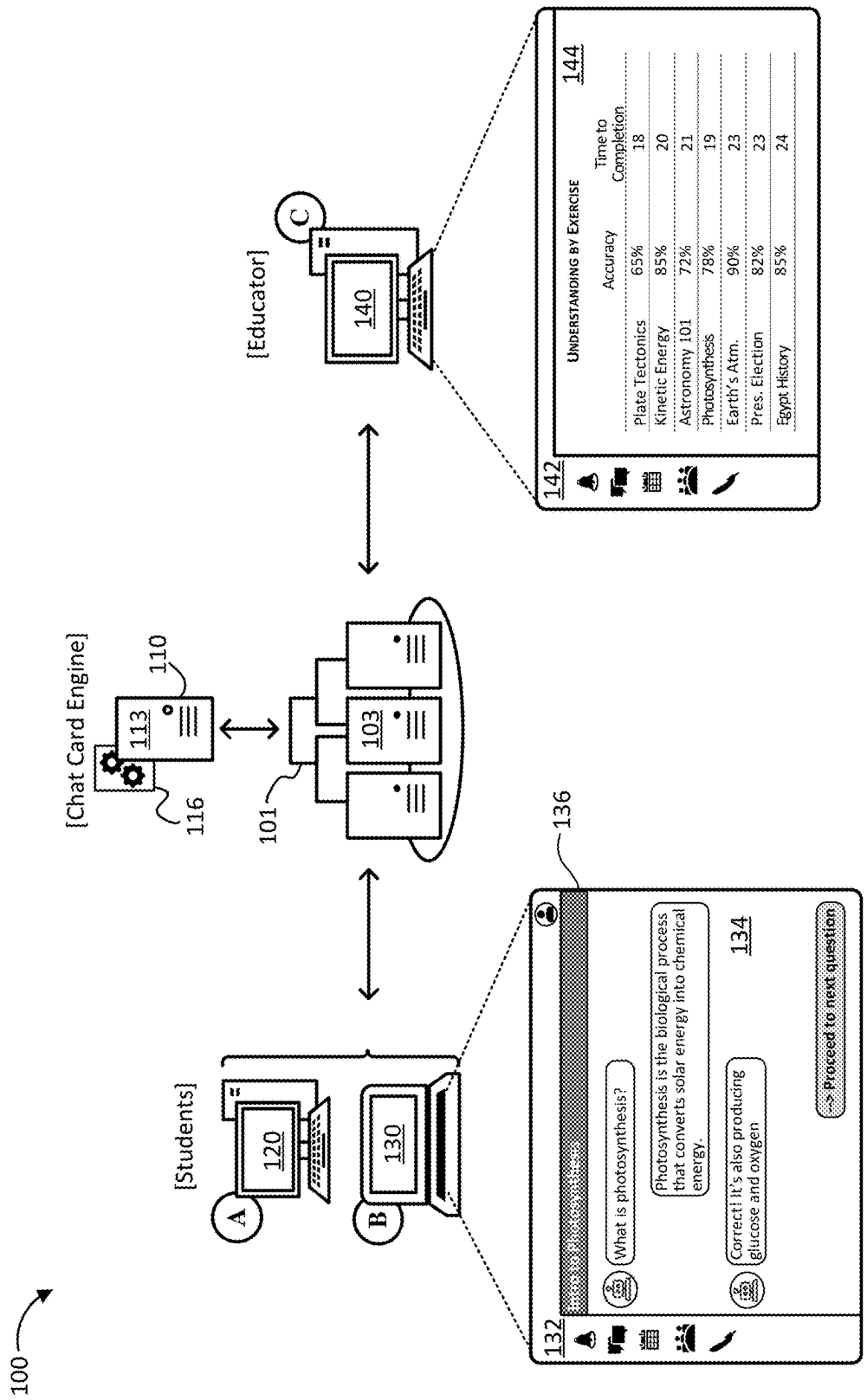

100
[Students]
A
120
B
130
[Chat Card Engine]
110
113
116
101
103
136
[Educator]
C
140
132
What is photosynthesis?
Photosynthesis is the biological process that converts solar energy into chemical energy.
Correct! It's also producing glucose and oxygen
134
Proceed to next question
142
144
UNDERSTANDING BY EXERCISE
Accuracy
Time to Completion
Plate Tectonics 65% 18
Kinetic Energy 85% 20
Astronomy 101 72% 21
Photosynthesis 78% 19
Earth's Atm. 90% 23
Pres. Election 82% 23
Egypt History 85% 24

FIG. 1

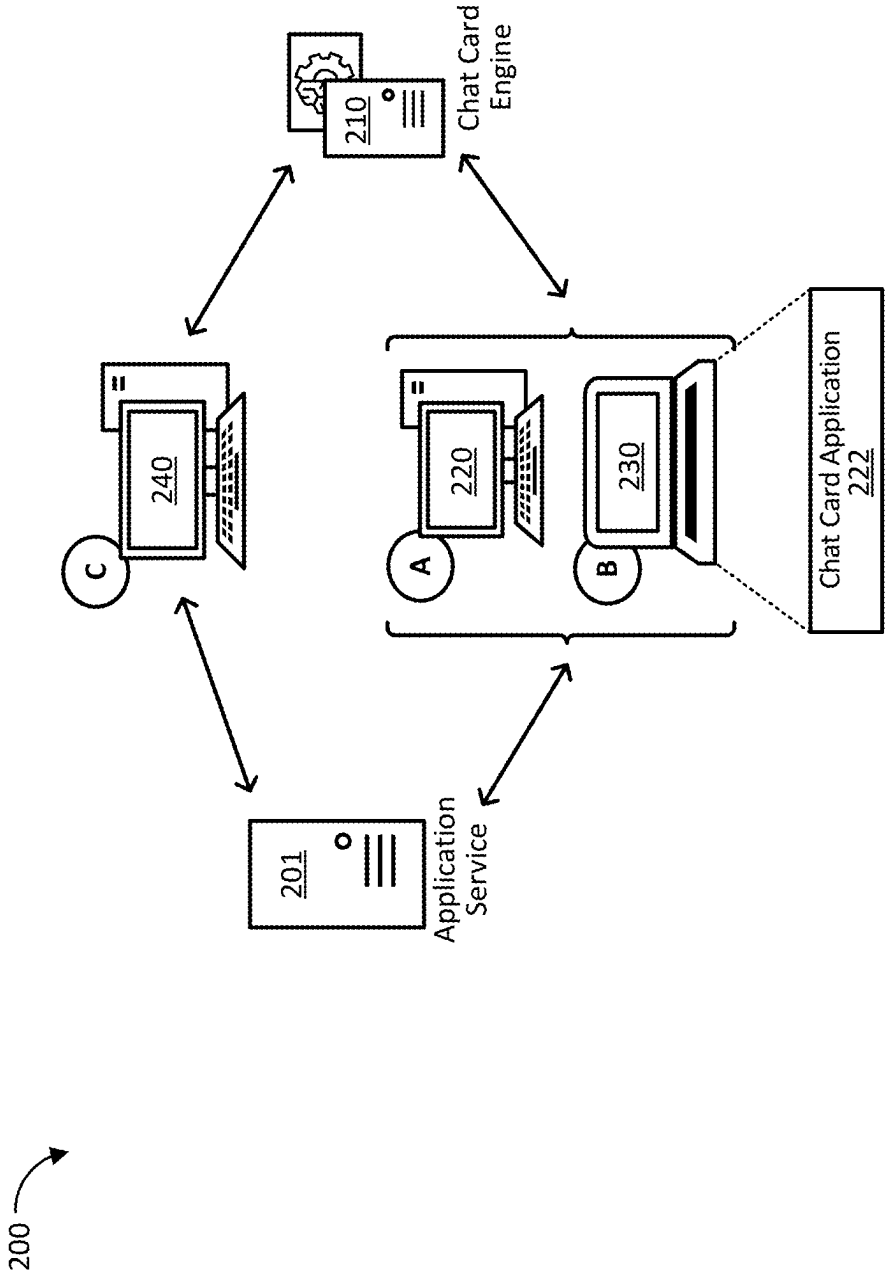

200
210
Chat Card Engine
240
220
230
A
B
C
Chat Card Application 222
201
Application Service

FIG. 2

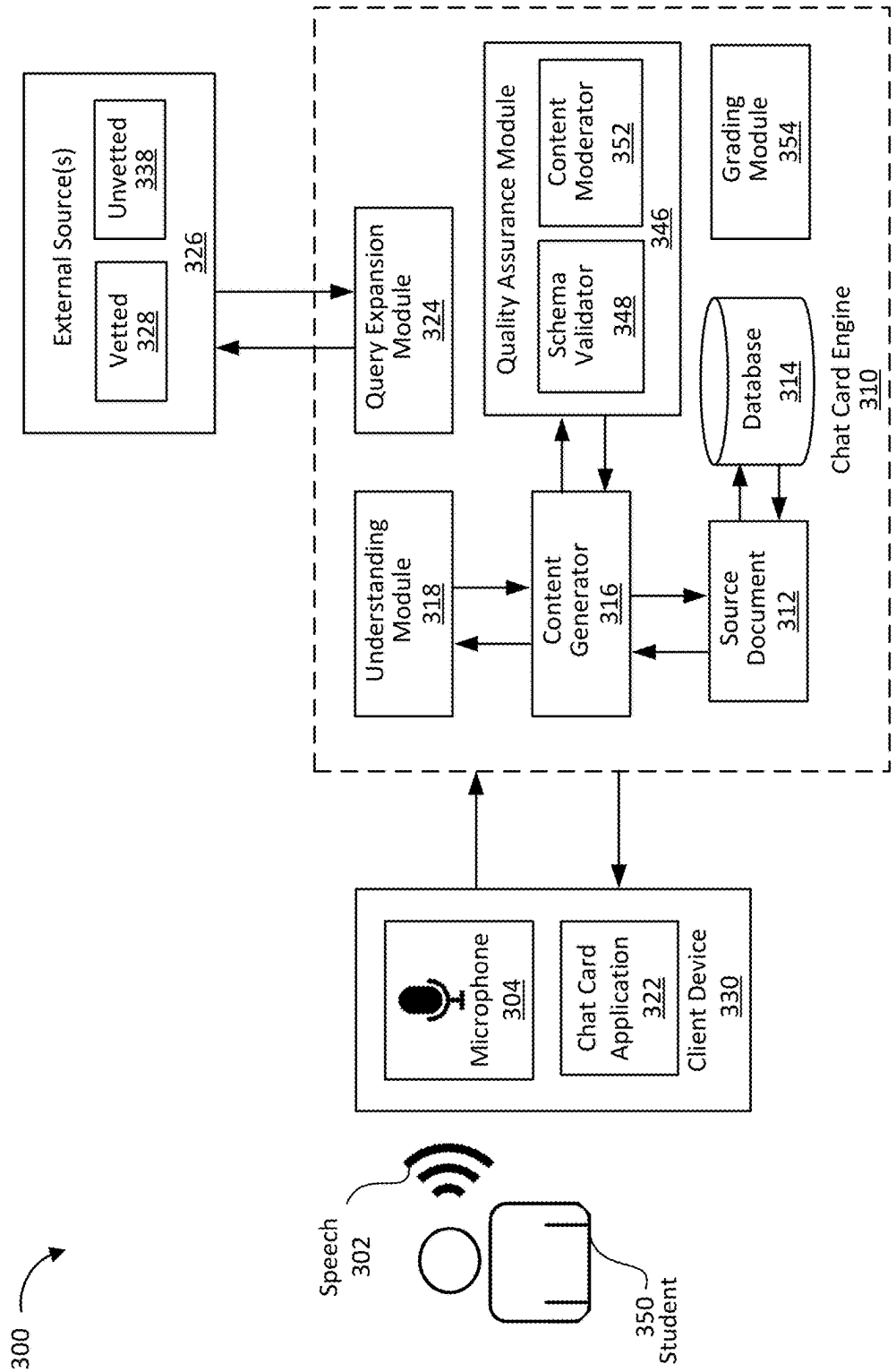

300
Speech
302
350
Student
Client Device
330
Microphone
304
Chat Card
Application
322
Chat Card Engine
310
Understanding
Module
318
Content
Generator
316
Source
Document
312
Database
314
Quality Assurance Module
346
Schema
Validator
348
Content
Moderator
352
Grading
Module
354
Query Expansion
Module
324
External Source(s)
326
Vetted
328
Unvetted
338

FIG. 3

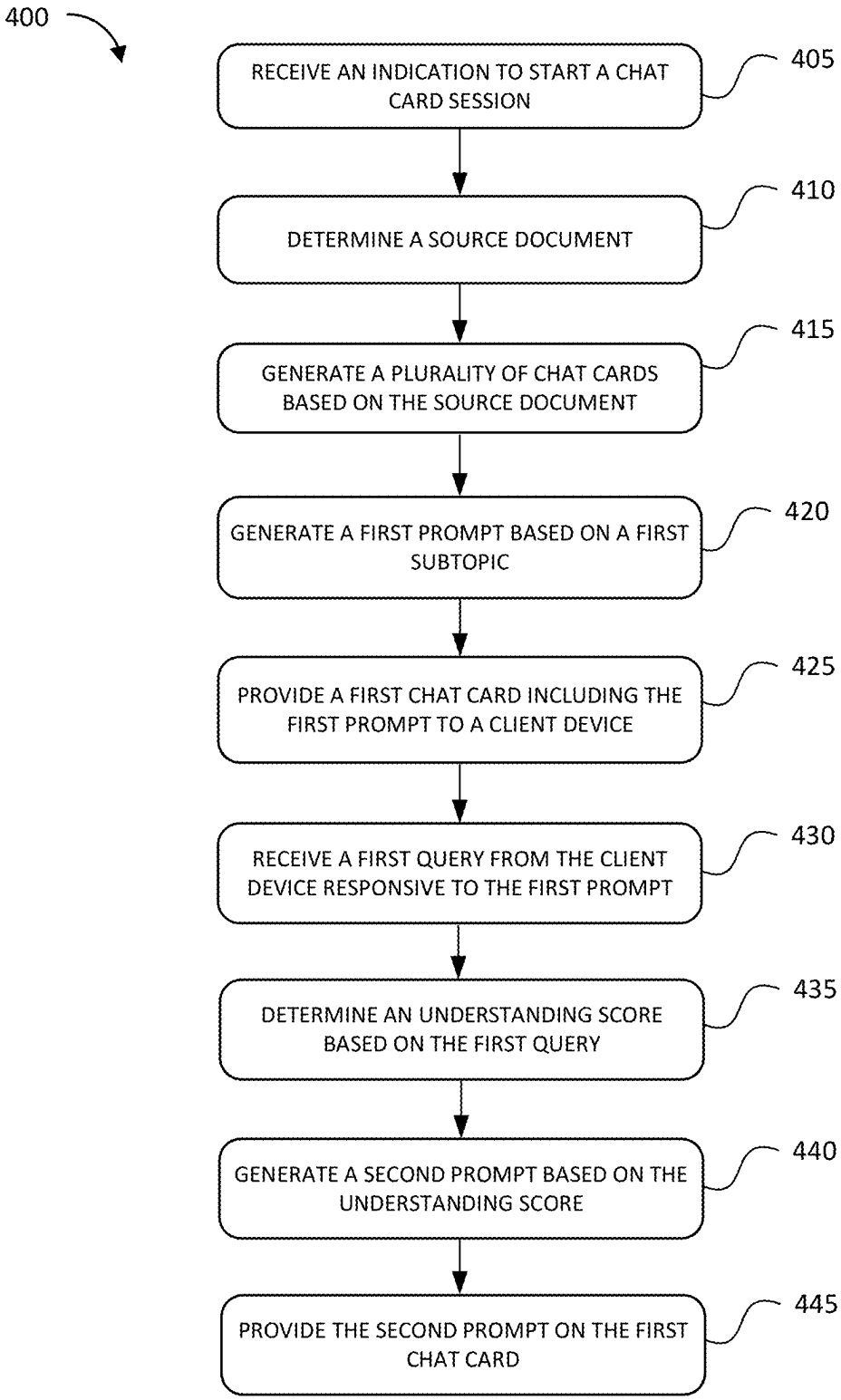

400
RECEIVE AN INDICATION TO START A CHAT CARD SESSION
405
DETERMINE A SOURCE DOCUMENT
410
GENERATE A PLURALITY OF CHAT CARDS BASED ON THE SOURCE DOCUMENT
415
GENERATE A FIRST PROMPT BASED ON A FIRST SUBTOPIC
420
PROVIDE A FIRST CHAT CARD INCLUDING THE FIRST PROMPT TO A CLIENT DEVICE
425
RECEIVE A FIRST QUERY FROM THE CLIENT DEVICE RESPONSIVE TO THE FIRST PROMPT
430
DETERMINE AN UNDERSTANDING SCORE BASED ON THE FIRST QUERY
435
GENERATE A SECOND PROMPT BASED ON THE UNDERSTANDING SCORE
440
PROVIDE THE SECOND PROMPT ON THE FIRST CHAT CARD
445

FIG. 4

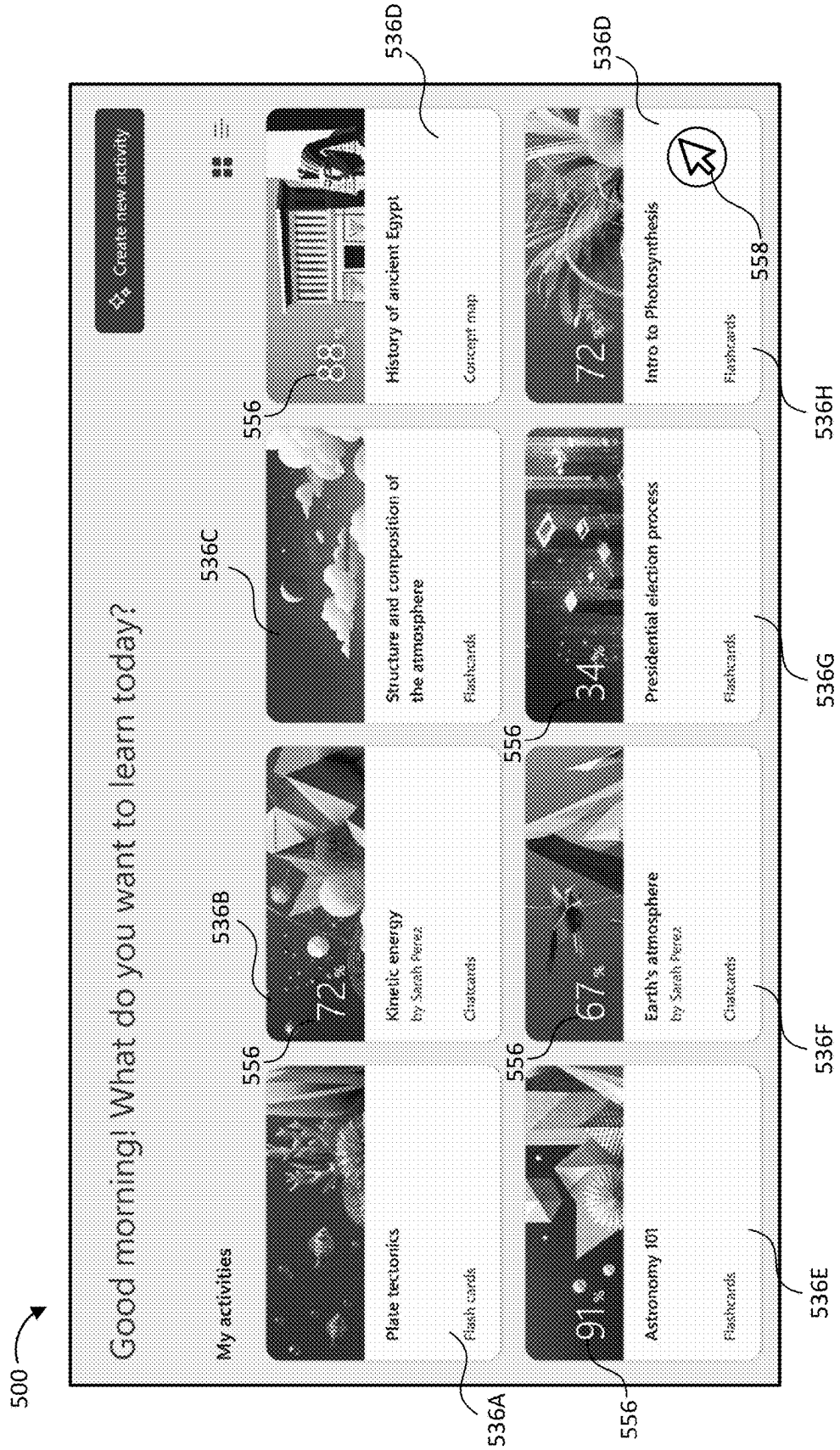

500
Good morning! What do you want to learn today?
Create new activity
My activities
Plate tectonics
Flash cards
536A
556
Kinetic energy
by Sarah Perez
Chatcards
536B
556
Structure and composition of the atmosphere
Flashcards
536C
556
History of ancient Egypt
Concept map
536D
556
Astronomy 101
Flashcards
556
Earth's atmosphere
by Sarah Perez
Chatcards
536F
556
Presidential election process
Flashcards
536G
556
Intro to Photosynthesis
Flashcards
536D
558
536H
536E

FIG. 5

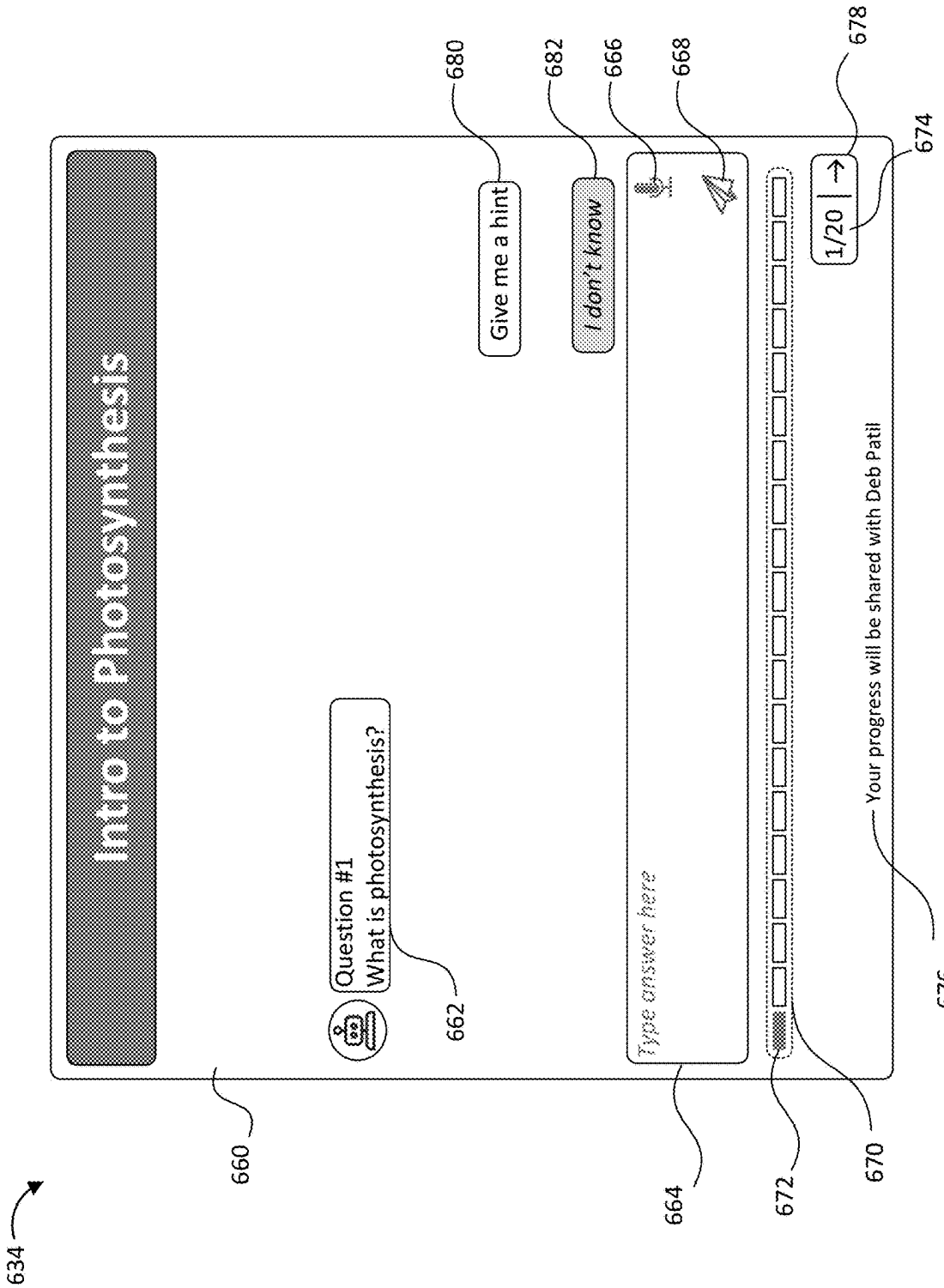

Intro to Photosynthesis
Question #1
What is photosynthesis?
Give me a hint
I don't know
Type answer here
1/20
Your progress will be shared with Deb Patil
634
660
662
664
666
668
670
672
674
676
678
680
682

FIG. 6

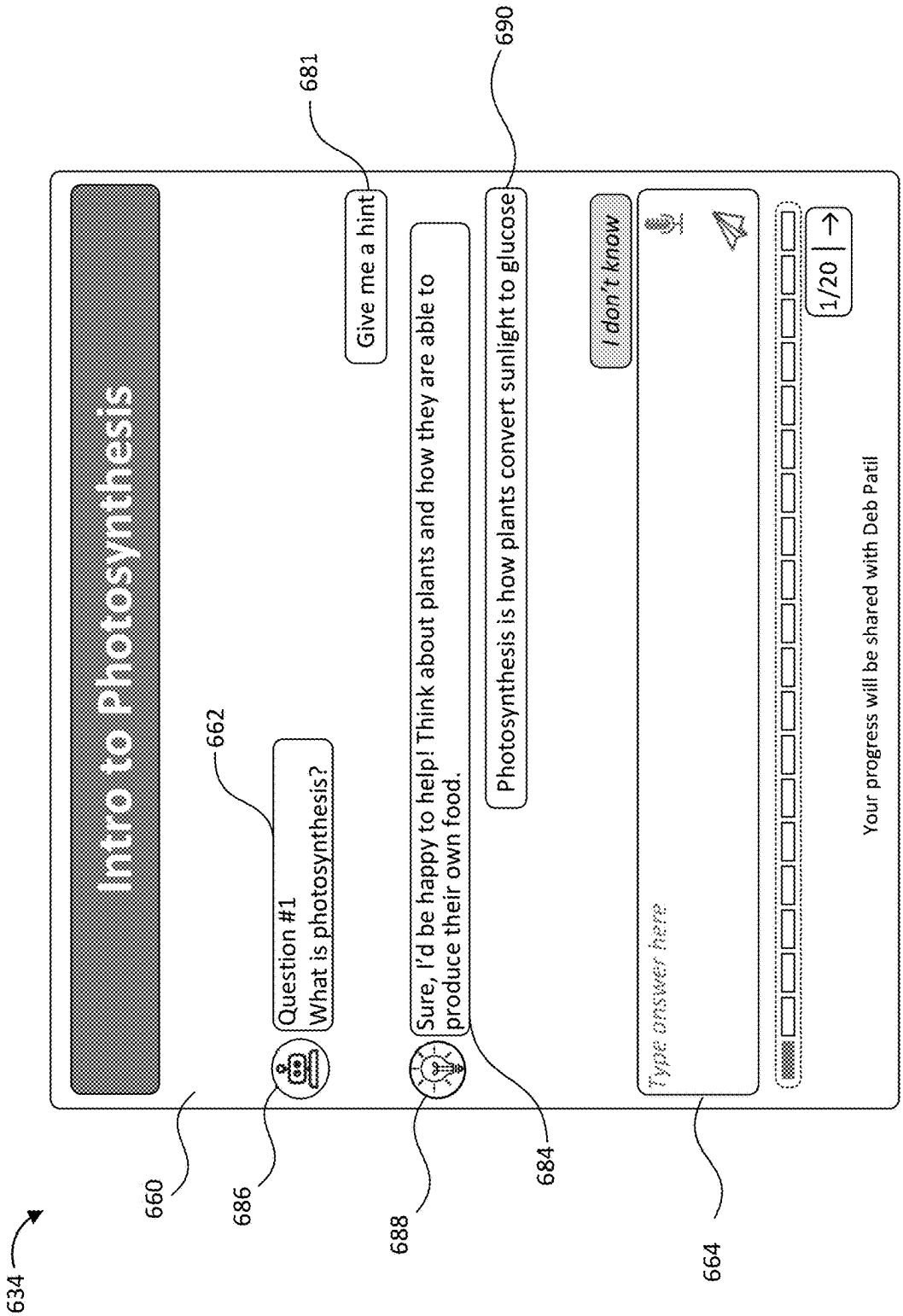

Intro to Photosynthesis
Question #1
What is photosynthesis?
Give me a hint
Sure, I'd be happy to help! Think about plants and how they are able to produce their own food.
Photosynthesis is how plants convert sunlight to glucose
I don't know
Type answer here
1/20
Your progress will be shared with Deb Patil
634
660
662
681
686
688
690
684
664

FIG. 7

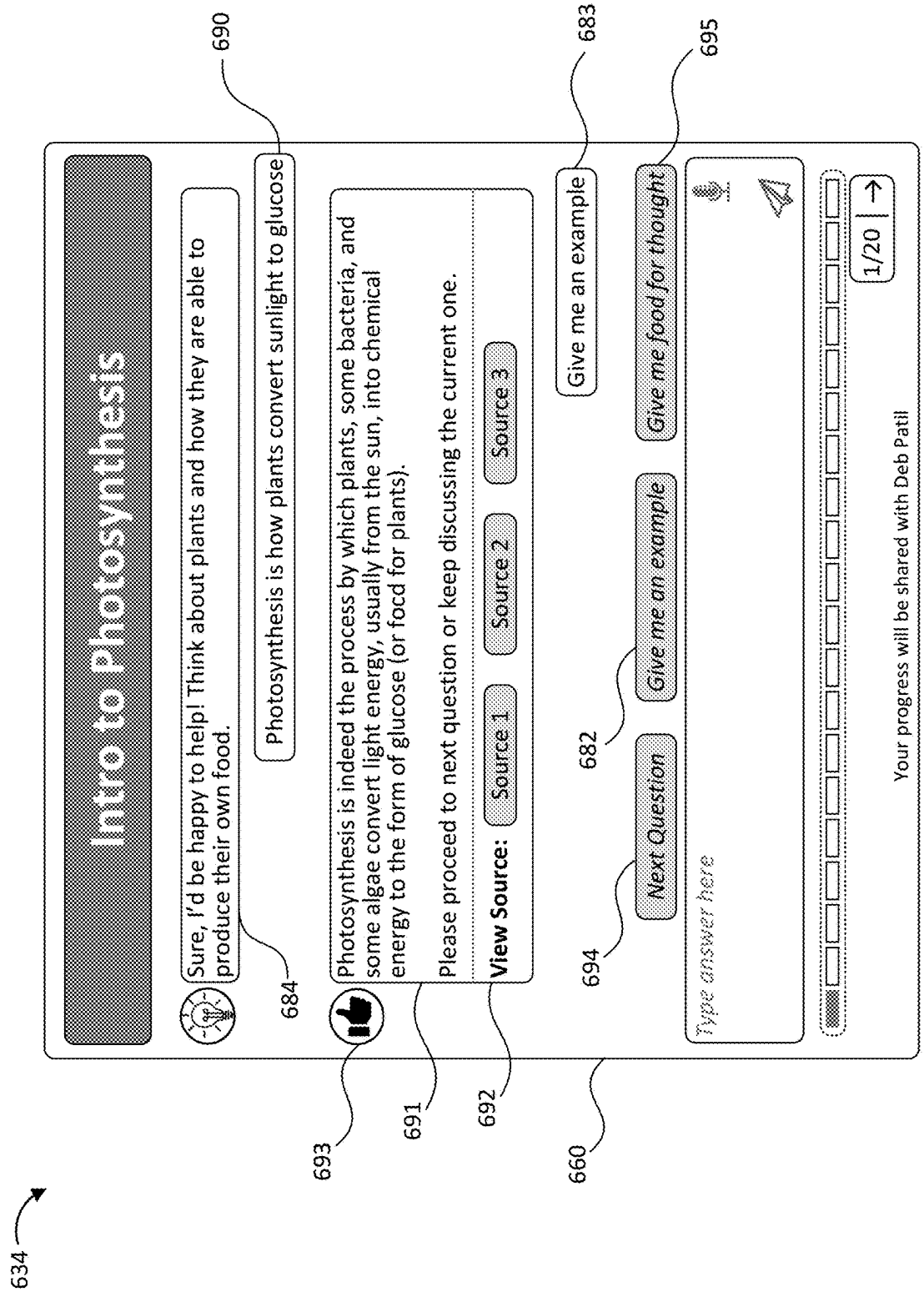

634
Intro to Photosynthesis
Sure, I'd be happy to help! Think about plants and how they are able to produce their own food.
684
690
Photosynthesis is how plants convert sunlight to glucose
693
Photosynthesis is indeed the process by which plants, some bacteria, and some algae convert light energy, usually from the sun, into chemical energy to the form of glucose (or focd for plants).
691
Please proceed to next question or keep discussing the current one.
View Source:
Source 1
Source 2
Source 3
692
660
683
Give me an example
682
694
Next Question
Give me an example
Give me food for thought
695
Type answer here
1/20
Your progress will be shared with Deb Patil

FIG. 8

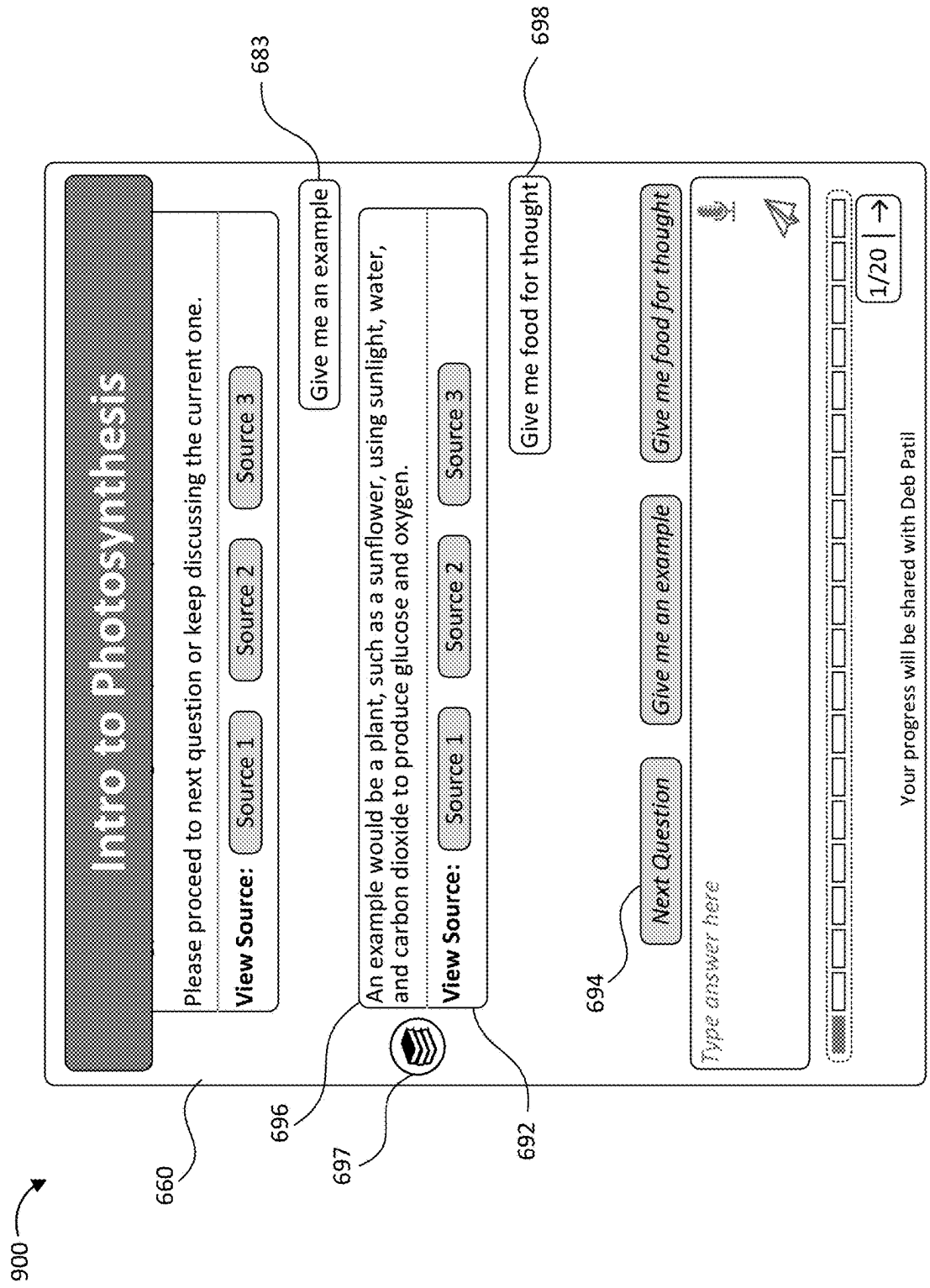

900
660
Intro to Photosynthesis
Please proceed to next question or keep discussing the current one.
View Source:
Source 1
Source 2
Source 3
683
Give me an example
696
An example would be a plant, such as a sunflower, using sunlight, water, and carbon dioxide to produce glucose and oxygen.
View Source:
Source 1
Source 2
Source 3
697
692
698
Give me food for thought
694
Next Question
Give me an example
Give me food for thought
Type answer here
1/20
Your progress will be shared with Deb Patil

FIG. 9

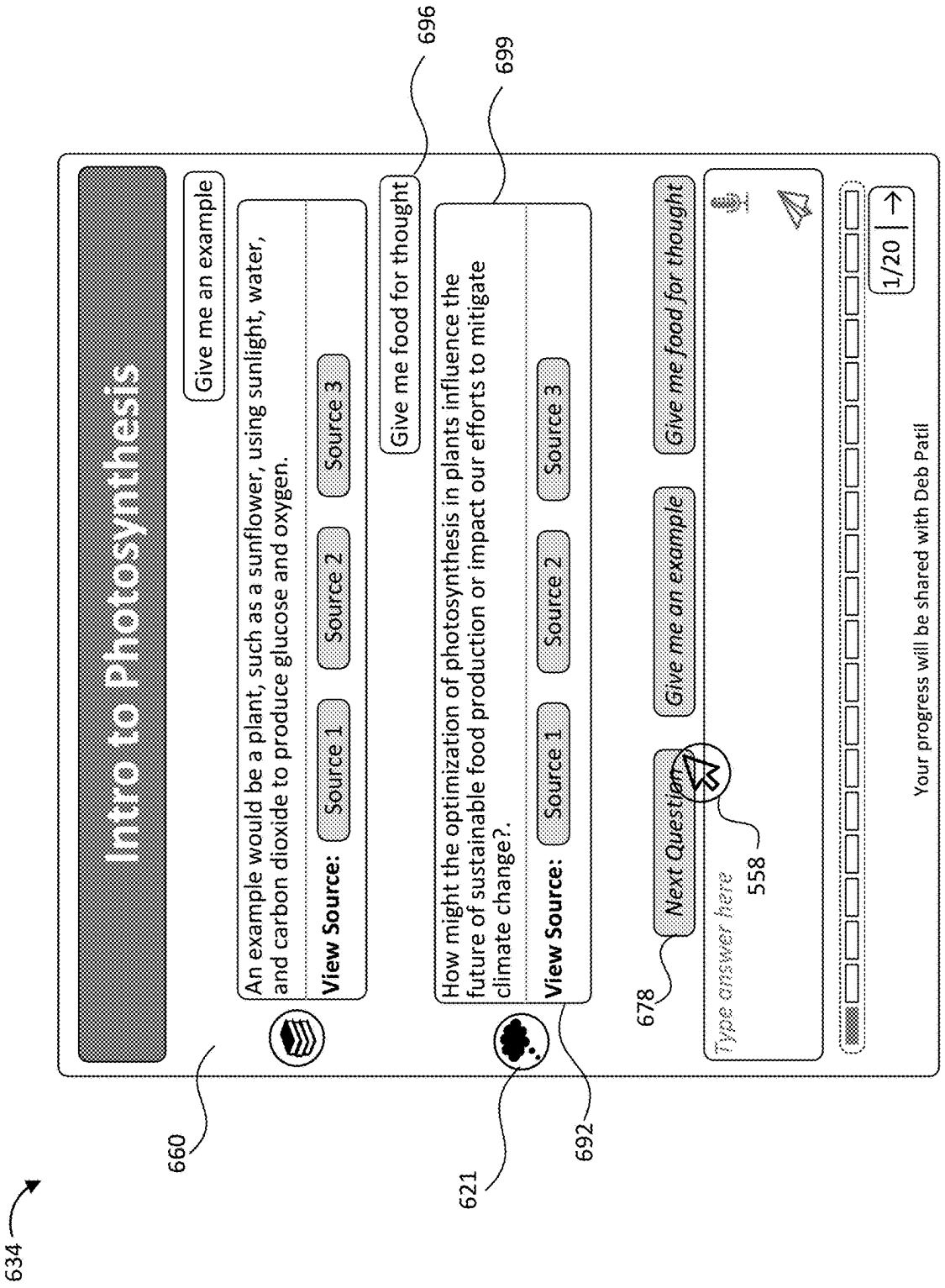

Intro to Photosynthesis
Give me an example
An example would be a plant, such as a sunflower, using sunlight, water, and carbon dioxide to produce glucose and oxygen.
View Source:
Source 1
Source 2
Source 3
Give me food for thought
How might the optimization of photosynthesis in plants influence the future of sustainable food production or impact our efforts to mitigate climate change?.
View Source:
Source 1
Source 2
Source 3
Next Question
Give me an example
Give me food for thought
Type answer here
1/20
Your progress will be shared with Deb Patil
634
660
621
692
678
558
696
699

FIG. 10

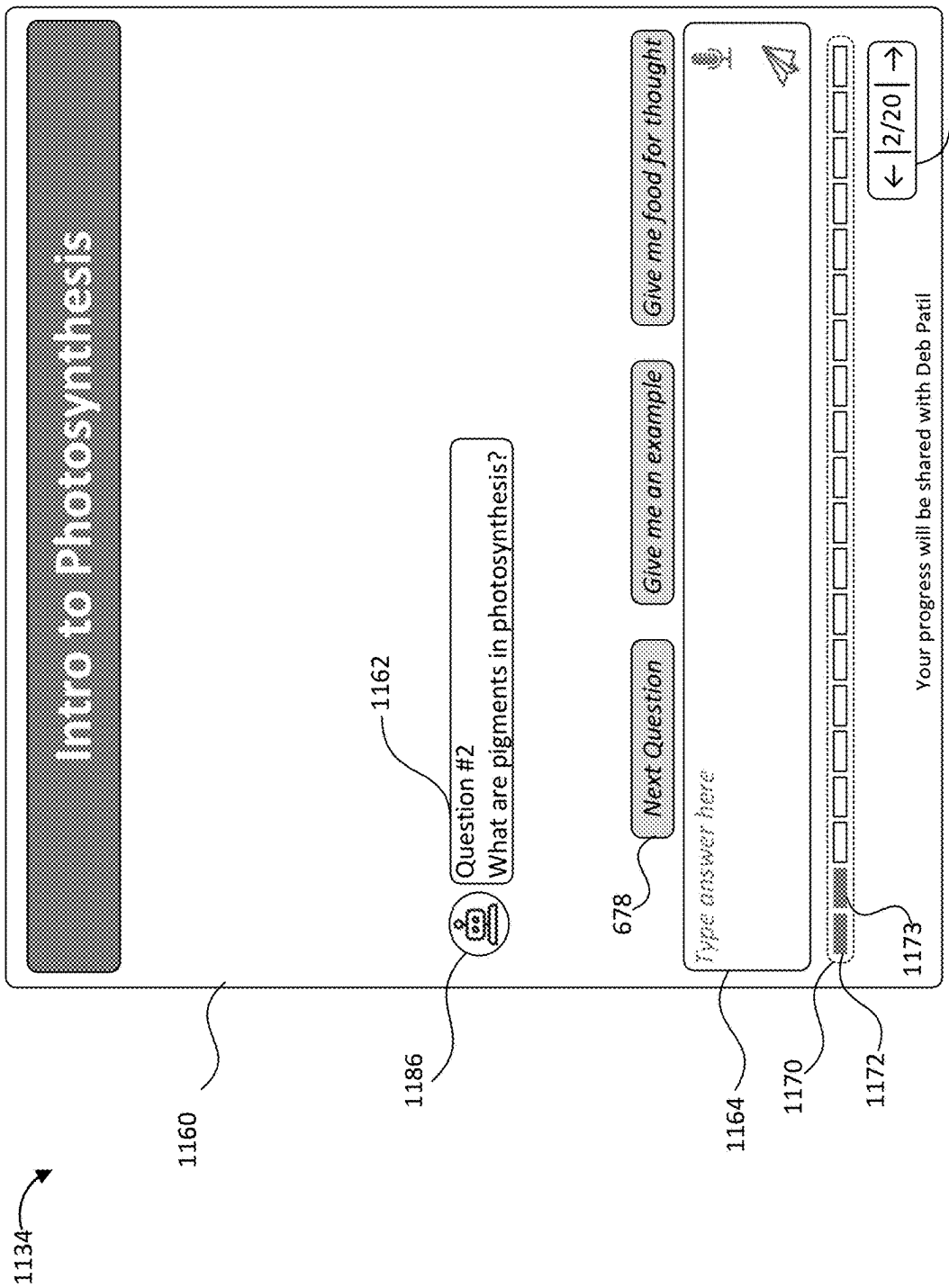

Intro to Photosynthesis
Question #2
What are pigments in photosynthesis?
Next Question
Give me an example
Give me food for thought
Type answer here
2/20
Your progress will be shared with Deb Patil
1134
1160
1162
1164
1170
1172
1173
1174
1186
678

FIG. 11

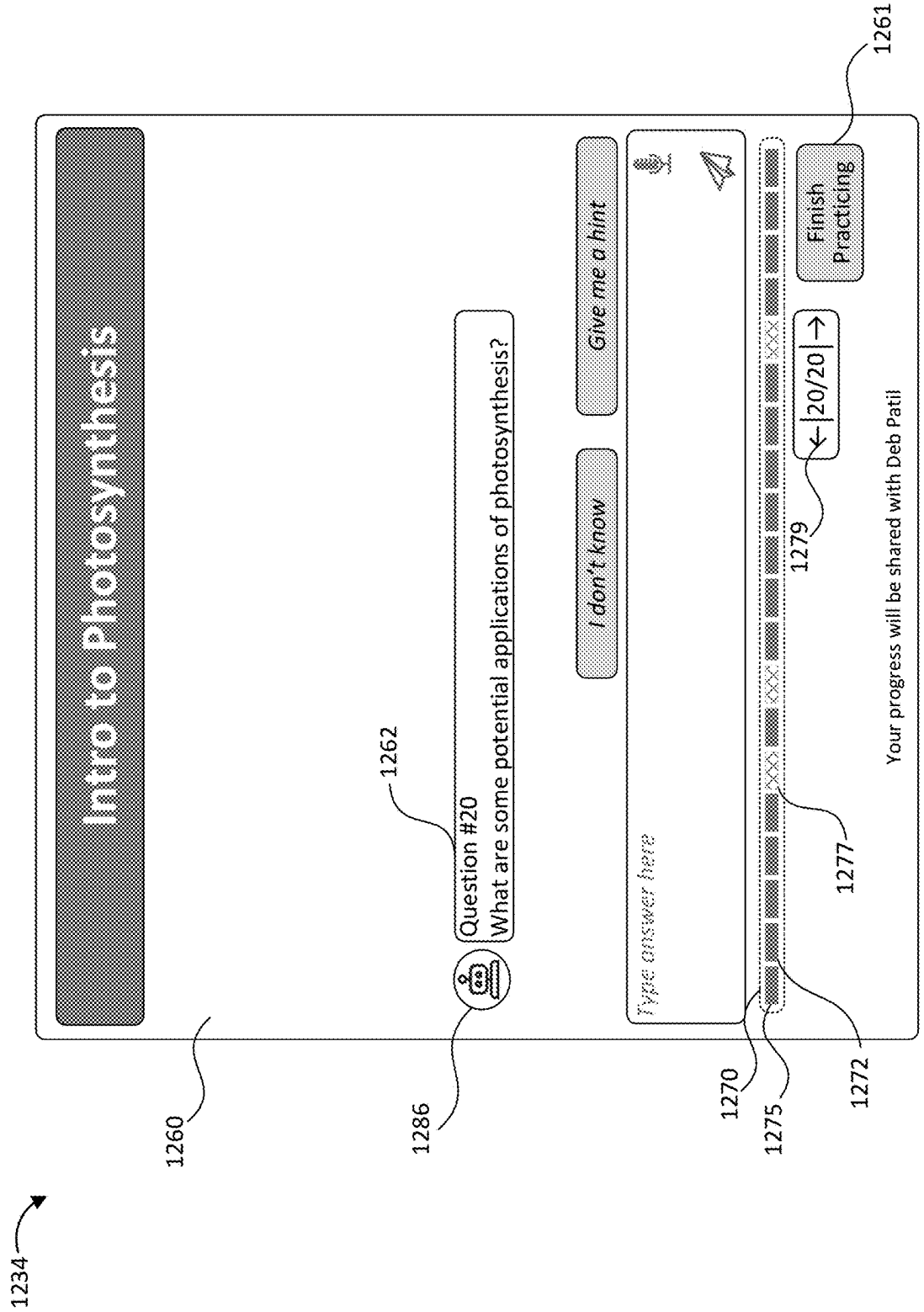

1234
1260
Intro to Photosynthesis
1262
Question #20
What are some potential applications of photosynthesis?
1286
I don't know
Give me a hint
Type answer here
1270
1275
1272
1277
1279
20/20
Finish Practicing
1261
Your progress will be shared with Deb Patil

FIG. 12

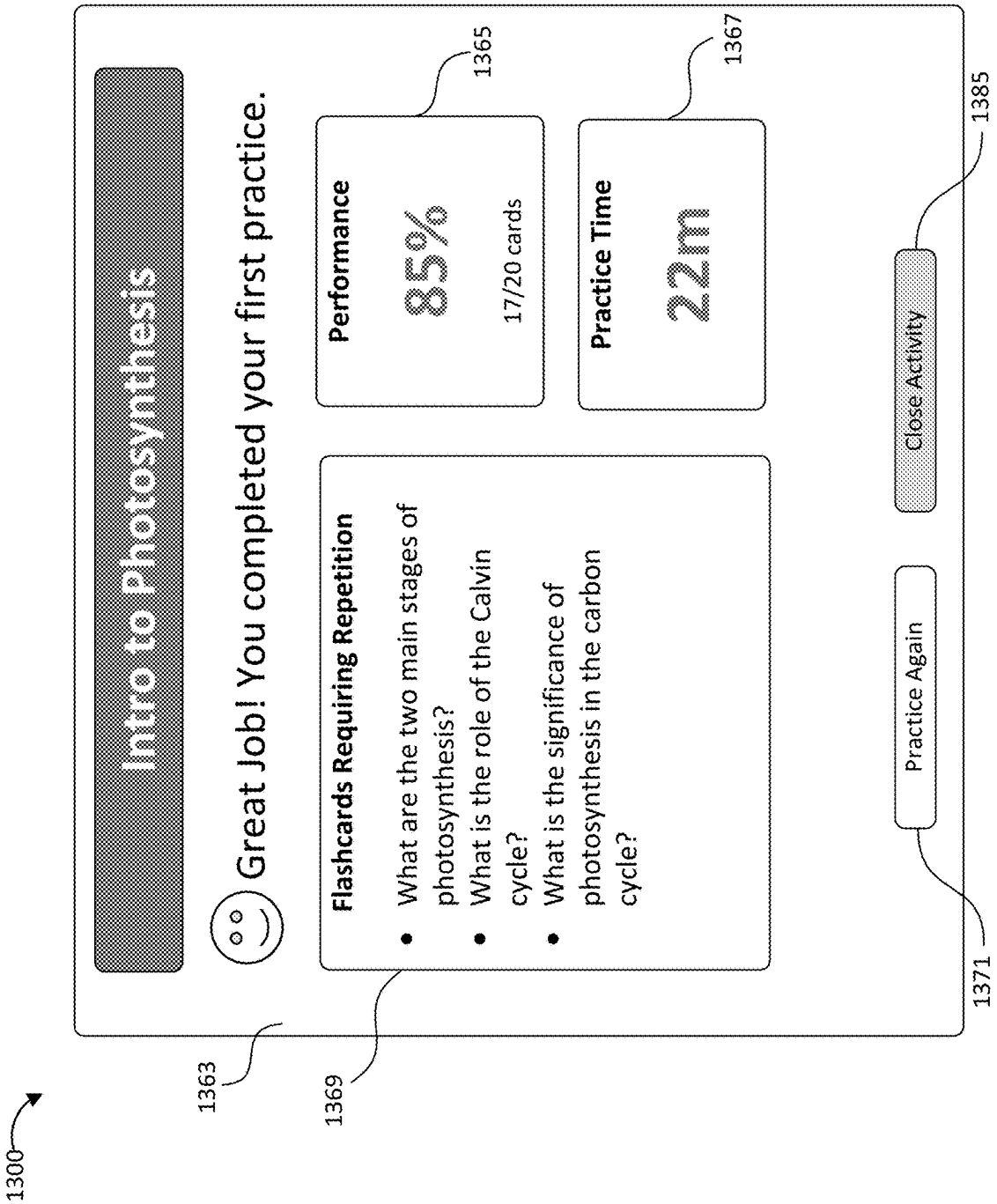

1300
1363
1369
1365
1367
1371
1385
Intro to Photosynthesis
Great Job! You completed your first practice.
Performance
85%
17/20 cards
Practice Time
22m
Flashcards Requiring Repetition
What are the two main stages of photosynthesis?
What is the role of the Calvin cycle?
What is the significance of photosynthesis in the carbon cycle?
Practice Again
Close Activity

FIG. 13

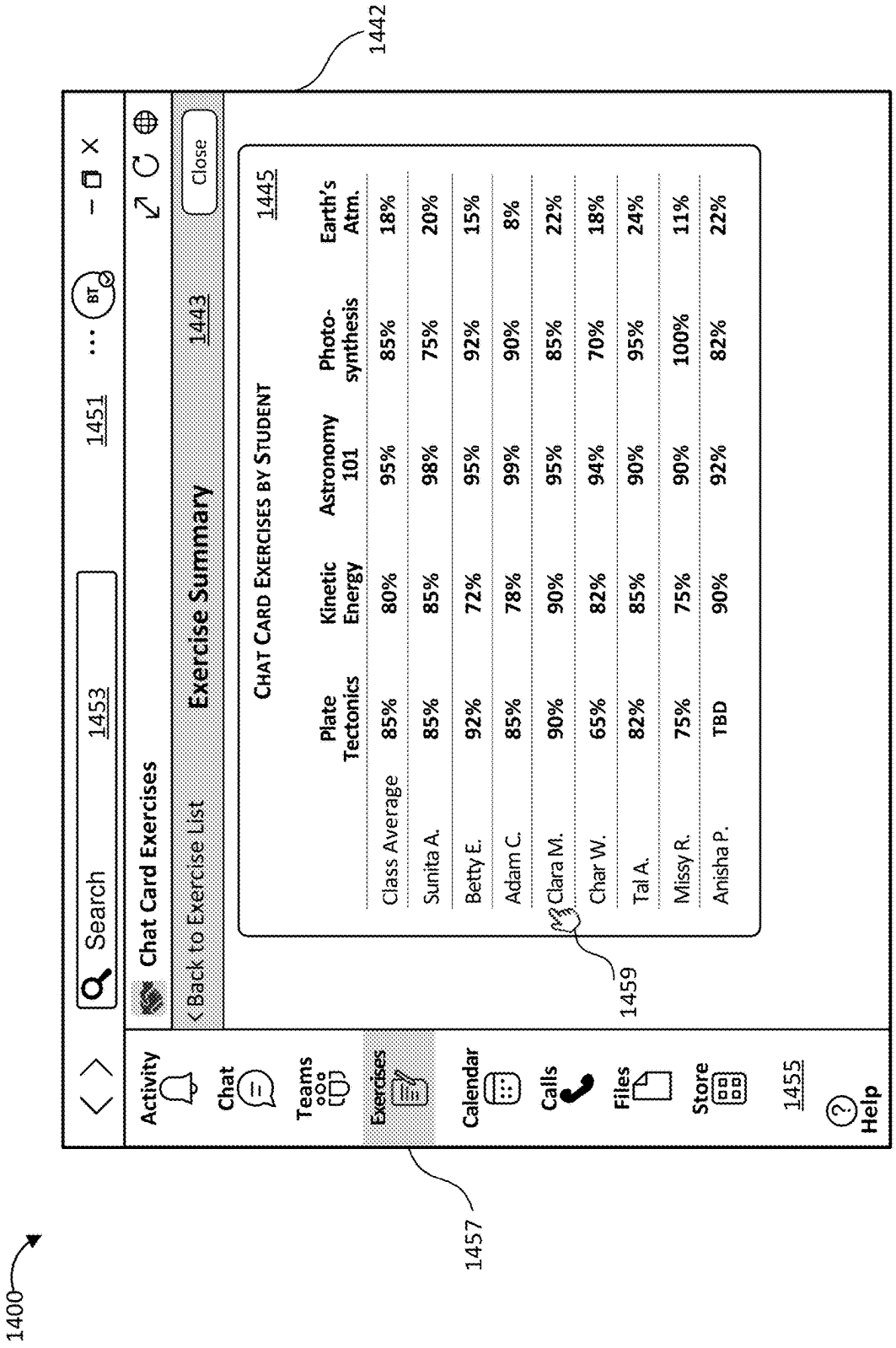

1400
1442
1451
Search
1453
Activity
Chat
Teams
Exercises
Calendar
Calls
Files
Store
1455
Help
Chat Card Exercises
< Back to Exercise List
Exercise Summary
1443
Close
CHAT CARD EXERCISES BY STUDENT
1445
Plate Tectonics
Kinetic Energy
Astronomy 101
Photo-synthesis
Earth's Atm.
Class Average 85% 80% 95% 85% 18%
Sunita A. 85% 85% 98% 75% 20%
Betty E. 92% 72% 95% 92% 15%
Adam C. 85% 78% 99% 90% 8%
Clara M. 90% 90% 95% 85% 22%
Char W. 65% 82% 94% 70% 18%
Tal A. 82% 85% 90% 95% 24%
Missy R. 75% 75% 90% 100% 11%
Anisha P. TBD 90% 92% 82% 22%
1459
1457

FIG. 14

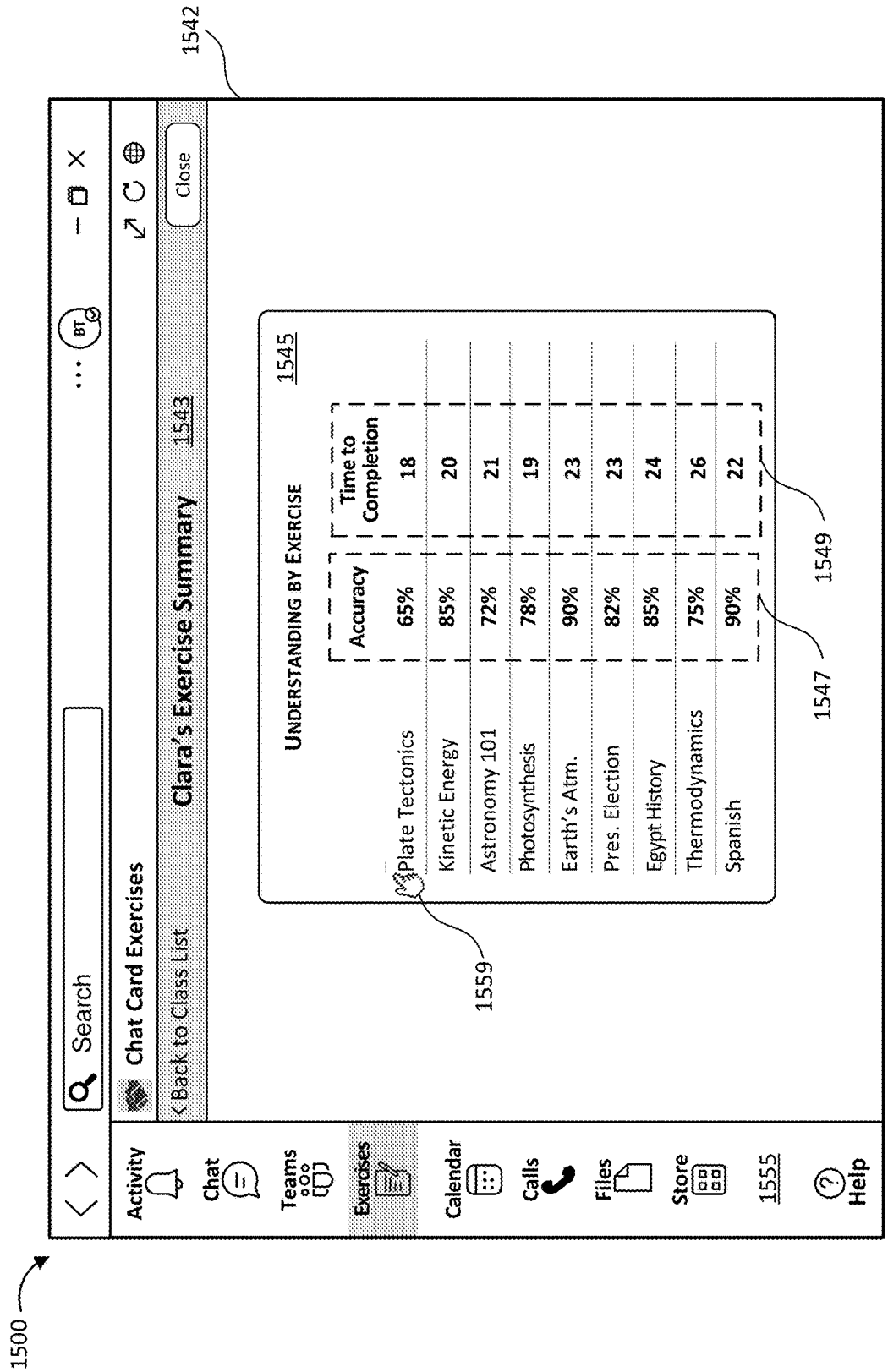

1500
Search
Activity
Chat
Teams
Exercises
Calendar
Calls
Files
Store
1555
Help
Chat Card Exercises
Back to Class List
Clara's Exercise Summary
1543
Close
1542
Understanding by Exercise
1545
Accuracy
Time to Completion
Plate Tectonics 65% 18
Kinetic Energy 85% 20
Astronomy 101 72% 21
Photosynthesis 78% 19
Earth's Atm. 90% 23
Pres. Election 82% 23
Egypt History 85% 24
Thermodynamics 75% 26
Spanish 90% 22
1559
1547
1549

FIG. 15

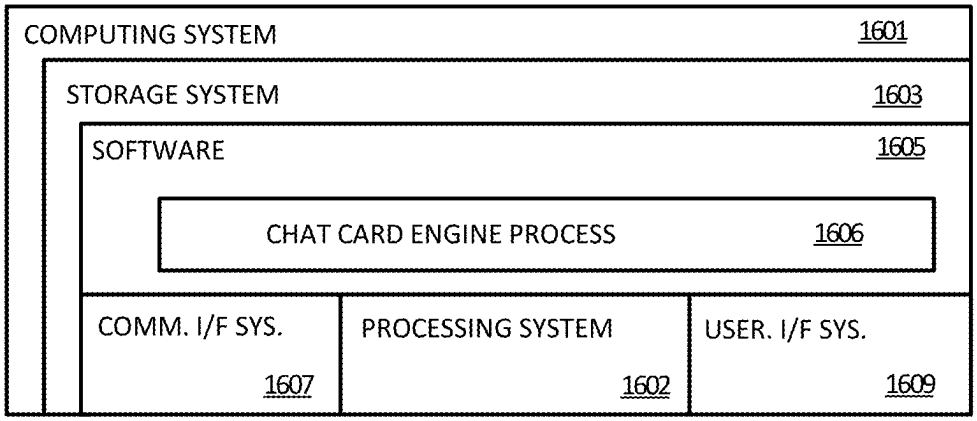

COMPUTING SYSTEM
1601
STORAGE SYSTEM
1603
SOFTWARE
1605
CHAT CARD ENGINE PROCESS
1606
COMM. I/F SYS.
1607
PROCESSING SYSTEM
1602
USER. I/F SYS.
1609

FIG. 16

CHAT CARD ENGINE(S) FOR CONVERSATIONAL CHAT CARDS

TECHNICAL FIELD

[0001] Aspects of the disclosure are related to the field of computer software applications and services and, in particular, to chat card engines for generating conversational chat cards which provide adaptive and enhanced learning exercises within educational environments.

BACKGROUND

[0002] Learning is a fundamental aspect of personal and academic growth, and its importance cannot be overstated. It is the process through which individuals acquire knowledge, skills, and understanding, providing the foundation for success in various facets of life. In this dynamic educational landscape, tools that facilitate effective learning become invaluable. Flashcards emerge as a powerful aid in this journey, offering a targeted and interactive approach to mastering new subjects. The concise format of flashcards encourages focused study, breaking down complex information into manageable snippets. Through repeated exposure to these bite-sized pieces of information, students engage in active recall, reinforcing their memory and understanding of key concepts. The process of creating and using flashcards not only enhances memorization but also promotes self-assessment, enabling students to identify areas that require further attention. In essence, flashcards serve as a versatile tool that aligns with the natural processes of human memory, making learning more efficient and enjoyable for students as they navigate the intricacies of various subjects.

[0003] Conventional flashcards, however, come with inherent limitations that hinder the development of a deeper understanding of the subject matter. One notable downfall is the lack of room for dialogue or the exploration of more profound questions. Flashcards typically present isolated pieces of information, focusing on rote memorization rather than encouraging critical thinking or interactive engagement. The one-sided nature of flashcards limits students' ability to delve into the nuances of a topic, inhibiting the development of a comprehensive understanding. Learning is not just about recalling facts; it involves the ability to connect information, analyze contexts, and ask probing questions. Conventional flashcards, with their succinct format, often fall short in fostering these essential aspects of learning.

[0004] Another significant downfall of conventional flashcards lies in their limited adaptability to individualized learning needs. Typically, the subject matter of flashcards tends to be standardized and generic, lacking the flexibility to cater to the unique requirements of individual classrooms or users. This lack of customization hinders the alignment of flashcard content with specific curriculum nuances or the diverse learning styles within a classroom. Educational content should ideally be tailored to resonate with the specific goals and preferences of students. Conventional flashcards, with their pre-determined content, often fall short in accommodating this need for personalization. In an era where personalized and adaptive learning approaches are gaining prominence, the static nature of traditional flashcards proves to be a constraint, limiting their effectiveness in addressing the diverse and dynamic educational landscape. As educators strive to create engaging and tailored learning experiences, exploring more flexible and customizable alternatives becomes crucial in overcoming this particular drawback associated with conventional flashcards.

[0005] As such, there is a need for a chat card engine, and its related functions, for providing enhanced and conversational chat cards that allow students to engage in a dialogue involving a given topic. That is, there is a need for more engaging learning approaches when it comes to learning new subject matter, such as providing a succinct platform, like the chat cards provided herein, which extend studying beyond rote memorization and short term recall; instead encouraging students to engage with the material and ask thought provoking questions.

SUMMARY

[0006] Technology disclosed herein includes software applications and services that provide a chat card engine, and its related functions, for generating conversational chat cards which provide adaptive and enhanced learning exercises within educational environments. In particular, an example chat card engine is provided herein to provide adaptive and conversational chat cards. As will be described in greater detail below, the chat cards provided herein tailor the flash card experience to an individual student's needs and provide a more engaging experience by allowing a student to participate in a conversation with the chat card engine.

[0007] To provide a chat card exercise including multiple chat cards, the chat card engine may determine a source document corresponding to the chat card exercise. For example, the student may select a desired chat card exercise to begin, and the chat card engine may identify the corresponding source document. The source document may be learning material that is provided to the chat card engine, for example, by the student or a reviewing user (e.g., an educator). In some cases, the chat card engine may analyze the source document to determine a topic and subtopics that fall under the topic. The chat card exercise may cover the topic, while each of the chat cards within the chat card exercise may be directed to a subtopic within the topic.

[0008] Once the source document is determined, the chat card engine may generate the chat cards to be included within the chat card exercise. As noted above, each of the chat cards may correspond to a subtopic present in the source document. For each of the chat cards, the chat card engine may generate a first prompt corresponding to a respective subtopic and provide the chat card including the first prompt to a client device, such as a client device corresponding to a student.

[0009] Responsive to receiving the chat card, the student may provide a first query to the chat card engine. As will be expanded on below, the first query may be a variety of different types of queries, such as an off-topic query, an example query, a hint query, or an exploratory query. Based on the type of query, the chat card engine **310** may generate a corresponding prompt. Additionally, the chat card engine **310** may determine an understanding score based on the received query. The understanding score may indicate whether or not the student understands the subtopic. Once an advancing understanding is determined, then the student may progress to the next chat card within the chat card exercise.

[0010] As will be evident by the below description, the chat card engine uses an adaptive and conversational environment to foster student engagement with the chat card exercise. When students are emotionally or intellectually engaged with learning material, they are more likely to invest cognitive effort needed for comprehension and retention of the subject material. As such, enhanced engagement with the subtopics of a chat card exercise aids in learning and retention of the learning material. By allowing the student to ask for hints, examples, and make exploratory requests (e.g., ask thought-provoking questions), the chat card engine enhances the student's investment in the chat card exercise, thereby improving the student's cognitive and emotional ties to the learning material.

[0011] From the educator's perspective, the chat card engine provides vital insight into the learning process for individual students, as well as a class as a whole, on the topics and subtopics covered by chat card exercises. The chat card engine evaluates how students perform on a chat card exercise, such as how accurately each of the chat cards were answered, and provides a summary to a respective educator. By providing educators with insights into how students are performing on exercises, the chat card engine allows educators to understand how material is received by students and what materials need to be revisited in future lessons. In other words, the chat card engine provides educators with information needed to tailor an overall class or curriculum to the needs of each individual classroom, thereby providing an enhanced learning environment.

[0012] This Summary is provided to introduce a selection of concepts in a simplified form that are further described below in the Technical Disclosure. It may be understood that this Overview is not intended to identify key features or essential features of the claimed subject matter, nor is it intended to be used to limit the scope of the claimed subject matter.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] Many aspects of the disclosure may be better understood with reference to the following drawings. The components in the drawings are not necessarily to scale, emphasis instead being placed upon clearly illustrating the principles of the present disclosure. Moreover, in the drawings, like reference numerals designate corresponding parts throughout the several views. While several embodiments are described in connection with these drawings, the disclosure is not limited to the embodiments disclosed herein. On the contrary, the intent is to cover all alternatives, modifications, and equivalents.

[0014] FIG. **1** illustrates an operational environment for providing a chat card engine for providing chat cards, according to an embodiment herein;

[0015] FIG. **2** illustrates a brief operational scenario to further highlight an application of the chat card engine, according to an embodiment provided herein;

[0016] FIG. **3** illustrates a system for providing a chat card engine and related functions, according to an embodiment herein;

[0017] FIG. **4** illustrates a process for providing the chat card engine and its related functions, according to an embodiment herein;

[0018] FIG. **5** illustrates an example chat card dashboard, according to an embodiment herein;

[0019] FIG. **6** illustrates an example chat card generated by a chat card engine, according to an embodiment herein;

[0020] FIG. **7** illustrates an example hint prompt generated by a chat card engine, according to an embodiment herein;

[0021] FIG. **8** illustrates an example correct answer prompt generated by a chat card engine, according to an embodiment herein;

[0022] FIG. **9** illustrates an example prompt generated by a chat card engine, according to an embodiment herein;

[0023] FIG. **10** illustrates an example exploratory prompt generated by a chat card engine, according to an embodiment herein;

[0024] FIG. **11** illustrates an example second chat card generated by the chat card engine, according to an embodiment herein;

[0025] FIG. **12** illustrates an example final chat card within a chat card exercise, according to an embodiment herein;

[0026] FIG. **13** illustrates a graphical user interface (GUI) for providing a completion card for a chat card exercise, according to an embodiment herein;

[0027] FIG. **14** provides a GUI illustrating metrics by student within a group across multiple chat card exercises, according to an embodiment herein;

[0028] FIG. **15** provides a GUI illustrating metrics for a selected student across multiple chat card exercises, according to an embodiment herein; and

[0029] FIG. **16** shows an example client device suitable for providing a chat card engine and related functions, according to an embodiment herein.

DETAILED DESCRIPTION

[0030] Flashcards have established themselves as a ubiquitous and widely embraced tool for learning new material. Their simplicity and effectiveness make them a common choice among students and educators alike. The format of flashcards, typically consisting of a concise question or prompt on one side and the corresponding answer on the other, facilitates quick and focused review. This streamlined approach promotes active recall, aiding in the reinforcement of key concepts and information. The portability of flashcards allows learners to study anytime, anywhere, making them a convenient companion for students with diverse schedules. Additionally, the repetitive nature of reviewing flashcards contributes to the consolidation of knowledge, enhancing long-term retention. Whether used for memorizing vocabulary, mastering mathematical formulas, or grasping historical facts, flashcards have proven to be a versatile and accessible means for learners to engage with and internalize new material effectively.

[0031] Despite their popularity, flashcards come with certain drawbacks that warrant careful consideration. One notable downfall is their inclination to promote surface-level learning, emphasizing rote memorization rather than cultivating a profound understanding of concepts. The concise format inherent in flashcards, with limited space for information, can inadvertently lead to a fragmented comprehension of complex topics. By simplifying information into isolated facts, flashcards may create a learning environment that prioritizes memorization over critical thinking and the exploration of interconnected ideas. While flashcards are effective for quick recall of specific details, the risk lies in students missing the broader context and connections within a subject.

[0032] Additionally, the static nature of flashcards poses another significant limitation by restricting their adaptability to the ever-evolving landscape of curricula and personalized educational needs. Educational approaches are dynamic, and curricula often undergo updates to align with the latest advancements and insights. In this context, the fixed content of flashcards may become outdated or fail to address emerging educational priorities. Moreover, the one-size-fits-all structure of conventional flashcards may not cater to the diverse learning preferences and individualized needs of students. A personalized learning journey requires flexibility and customization, allowing educators to tailor content to specific classroom dynamics and the unique learning styles of individual students or allowing students to focus on subject matter needed to advance his or her own learning journey. The static nature of flashcards may impede this adaptability, emphasizing the need for a more versatile and responsive approach to educational tools to ensure they remain effective and relevant in a rapidly changing educational landscape.

[0033] Moreover, the one-size-fits-all approach of conventional flashcards introduces yet another challenge, as it may not adequately cater to the diverse learning styles, individual preferences, and varying paces of students. Education is a deeply personal experience, and learners often engage more effectively when instructional methods align with their unique strengths and preferences. Additionally, students progress through material at different rates, with some mastering concepts swiftly while others benefit from a more gradual and deliberate pace. The rigid structure of traditional flashcards may limit their effectiveness in accommodating these varied learning styles and paces. Recognizing and embracing the diversity of how students absorb and process information, as well as respecting the individualized pace of learning, is essential for creating an inclusive and effective learning environment. As educators explore innovative teaching tools, it becomes imperative to consider alternatives that can be tailored to the individualized needs and pacing of students, fostering a more inclusive and engaging educational experience.

[0034] To address these and other shortcomings, an example chat card engine, and its related functions, is provided herein to provide conversational chat cards that allow students to actively engage with subtopics of a given subject matter until he or she understands the material. That is, the chat cards provided herein allow students to ask questions, request examples or hints, and write explanations of a subtopic instead of merely providing a one-dimensional answer to the question provided by the chat card. By following the general structure of a flashcard, the chat cards provide a succinct technique for engaging with a subtopic of material that is part of a broader subject matter. As such, a chat card allows a student to dive deeper into the subtopic of the chat card, asking thought provoking questions or requesting examples, until the student understands the material. As will be expanded on below, the chat card engine may determine that the student understands the subtopic based on queries received from the student. Once the chat card engine determines that the student understands the subtopic, a new chat card is generated for a subsequent subtopic and provided to the student.

[0035] As can be appreciated, by allowing students to interact with the chat cards, such as by asking questions or requesting examples, students can cultivate a deeper and more profound understanding of the underlying concepts. That is, the chat cards prompt active learning which enhances retention and cultivates critical thinking skills, empowering students to analyze, question, and apply knowledge in diverse contexts. Moreover, the chat cards encourage curiosity, which is a cornerstone of effective learning and provides motivation to extend a student's study session and topic range.

[0036] The chat card engine generates the chat cards based on a source document. The source document may be a course syllabus, outline, or class notebook provided by an educator, a book or textbook relating to a class, or material that a student provides to the chat engine because he or she wants to learn the underlying subject matter. Because the chat card engine generates the chat cards based off a provided source document, the chat cards can be individualized to a student's interest or tailored to the specific curriculum of a given class. As can be appreciated, this allows the chat cards to be dynamic and update as subject matter on a given topic advances or allows students to focus on a topic of interest.

[0037] Furthermore, the chat card engine provides educators with information on how students grasp various topics and materials. That is, the chat card engine can track how well each student performs on chat card exercises including subtopics and can provide a summary to the educator. Such a summary can provide the educator with vital information on how material is received by students and provide insight on what concepts and subtopics should be the focus of future lessons.

[0038] Overall, the chat card engine, and related functionality, provided herein not only improves the educational environment by providing enhanced chat card exercises that encourage students to actively participate in their learning experience, but it also provides educators with vital information required to adapt their teaching approach to the students' pace, knowledge, and specific challenges. The chat card engine helps build a deeper conceptual understanding of underlying subject matter, promotes critical thinking skills, and instills confidence in students as they navigate the intricacies of the subject. By fostering students' curiosity and knowledge of a diverse range of topics, the chat card engine aids students with gaining essential problem-solving and critical thinking skills that are applicable in various real-world scenarios. Overall, the conversational and engaging approach provided by the chat card engine and the subsequent acquisition of knowledge and skills contribute not only to academic and professional success but also to the development of practical, transferable skills crucial for lifelong learning and success.

[0039] Turning now to FIG. **1**, FIG. **1** illustrates an operational environment **100** for providing a chat card engine for generating chat cards, according to an embodiment herein. As illustrated, the operational environment **100** includes an application service **101**, a chat card engine **110**, and client devices **120**, **130** and **140**. The application service **101** employs one or more server computers **103** co-located with respect to each other or distributed across one or more data centers. Example servers include web servers, application servers, virtual or physical servers, or any combination or variation thereof, of which computing system **1601** in FIG. **16** is broadly representative.

[0040] The client devices **120**, **130**, and **140** communicate with application service **101** via one or more internets and

intranets, the Internet, wired and wireless networks, local area networks (LANs), wide area networks (WANs), or any other type of network or combination thereof. Examples of the client devices **120**, **130**, and **140** may include personal computers, tablet computers, mobile phones, gaming consoles, wearable devices, Internet of Things (IoT) devices, and any other suitable devices, of which computing system **1601** in FIG. **16** is also broadly representative.

[0041] Broadly speaking, the application service **101** provides software application services to end points, such as the client devices **120**, **130**, and **140**, examples of which include productivity software for creating content (e.g., word processing, spreadsheets, and presentations), email software, and collaboration software. The client devices **120**, **130**, and **140** load and execute software applications locally that interface with services and resources provided by the application service **101**. The applications may be natively installed and executed applications, web-based applications that execute in the context of a local browser application, mobile applications, streaming applications, or any other suitable type of application. Example services and resources provided by the application service **101** include front-end servers, application servers, content storage services, authorization and authentication services, and the like.

[0042] The application service **101** also includes an integration with the chat card engine **110**, which is capable of generating chat cards based off a source document. As will be described in greater detail below, the chat card engine **110** generates chat cards based on a received source document and provides the chat cards to one or more of the client devices **120** and **130**. The chat card engine **110** also interacts with the client devices **120** or **130** via the chat cards and may report on a student's progress. In other words, the chat card engine **110** may include one or more functions that allow the chat card engine **110** to receive a source document from a client device, generate chat cards from the source document, interact with a student on a given chat card, and generate a summary of a student's process on a chat card or a chat card exercise based on the student's interactions via the application service **101**. In an example, the application service **101** may provide a chat card application through which the chat card engine **110** provides one or more of its functions.

[0043] To provide these functions, the chat card engine **110** employs one or more server computers **113** co-located with respect to each other or distributed across one or more data centers, of which computing system **1601** in FIG. **16** is broadly representative. In some embodiments, the chat card engine **110** hosts a content generator **116** on server computers **113** as well. In other embodiments, the content generator **116** may be hosted separately from the chat card engine **110**, such as by a third party. As will be described in greater detail below, the chat card engine **110** interacts with a user via the content generator **116**, such as a large language model (LLM).

[0044] The application service **101** hosts or provides an application, such as a chat card application, through which users of the client devices **120** and **130**, user A and user B, respectively, can practice or challenge their knowledge of various topics through. For example, the application service **101** may provide or host an educational application through which exercises are prepared by an educator, such as the user of the client device **140** (user C). Users A and B may be students in the illustrated example. As such, users A and B may perform and complete one or more chat card exercises provided by the application service **101** via a corresponding chat card application. As used herein, a chat card exercise includes multiple chat cards directed to related subtopics that fall under the broader topic of the chat card exercise. In other words, a chat card exercise may be directed to a topic, such as photosynthesis, and include chat cards each directed to a subtopic of photosynthesis, such as chlorophyll or photosynthetic pigments.

[0045] To generate a chat card exercise, the chat card engine **110** may receive a source document from which the chat card exercise is generated. For example, the chat card engine **110**, via the application service **101**, may receive a source document, such as a class textbook, from the client device **140**. In this scenario, user C may be an educator setting up chat card exercises for students within a class. In another scenario, user A may desire to practice his or her knowledge on a given topic and provide the chat card engine **110** with a source document containing information on that topic.

[0046] As can be appreciated, a source document may be any form of material that contains information on one or more topics. For example, the source document may be a lesson plan, syllabus, textbook, worksheet, educational handout, research paper, educational article or presentation, manual, study guide, book, or any other material containing subject matter on a topic. In some cases, the source document may be digitally transmitted, such as uploaded, to the chat card engine **110**, while in other cases, a link to the source document may be provided to the chat card engine **110**, from which the chat card engine **110** retrieves the source document or retrieves portions of the source document as needed. Various embodiments are described in greater detail below with respect to FIG. **3**.

[0047] Once the source document is received, the chat card engine **110** may generate one or more chat cards for a chat card exercise. For example, upon receipt of the source document the chat card engine **110** may generate the chat cards; however, in another example, the chat card engine **110** may generate the chat cards once an indication to start the exercise is received from the client device **120** or **130**. To generate the chat cards, the chat card engine **110** may identify one or more topics within the source document, and therefrom identify one or more subtopics for each topic. For example, if the source document is a textbook, the chat card engine **110** may identify each chapter in the textbook as a topic and then determine one or more subtopics within each chapter.

[0048] In another embodiment, instead of the chat card engine **110** determining the topic for a chat card exercise, an educator, such as user C, may identify the topic for a chat card exercise. Based on the identified topic, the chat card engine **110** may analyze the source document to determine subtopics within the identified topic. For each identified subtopic, the chat card engine **110** may generate a corresponding chat card. The group of the chat cards, each directed to a different subtopic under the broader topic, may be part of a chat card exercise.

[0049] Once generated by the chat card engine **110**, a first chat card **134** that is part of a chat card exercise **136** is provided to user B via a user interface **132** of an application (e.g., chat card application) executing on the client device **130**. As illustrated, the user interface **132** may provide the chat card exercise **136** including the generated chat card **134**. User B can interact with the chat card **134** via the user

interface **132**. Once user B completes the chat card **134**, such as by answering the prompt correctly, user B may be provided with a subsequent chat card within the chat card exercise until user B completes the chat card exercise **136**. Generation and interaction with the chat card **134** and the chat card exercise **136** are described in greater detail below with respect to FIGS. **3-15**.

[0050] Once user B completes the chat card exercise **136**, the chat card engine **110** may generate a report of the interaction. As can be appreciated, while interacting with the chat card **134**, user B may request hints, request examples, provide incorrect answers, ask thought provoking questions, request more information, or provide a correct answer to the chat card prompt. As such, the chat card engine **110** may monitor user B's interaction with the chat card **134** and provide a summary of the interactions with each chat card within the exercise **136**. In some cases, the summary of the interactions, such as which chat cards within the exercise user B answered correctly or incorrectly, may be provided to the user B upon completion of the chat card exercise **136**.

[0051] In other cases, the summary may be provided to user C, who may be an educator in this scenario. In such an example, the chat card engine **110** may generate a report or summary of the chat card exercise **136** for each student for whom user C supervises (e.g., each student within a class). User C may view the summary via a user interface **142** via an application executing on the client device **140**. As illustrated, the user interface **142** may include a summary **144** of the exercise as completed by user B via the user interface **132**. As will be described in greater detail below, the summary **144** may indicate how user B answered each of the chat cards within the chat card exercise **136**.

[0052] Turning now to FIG. **2**, FIG. **2** illustrates a brief operational scenario **200** to further highlight an application of the chat card engine, according to an embodiment provided herein. As shown, in operational scenario **200**, there are two observed users (e.g., students), users A and B, and a reviewing user (e.g., educator), user C. Users A and B may operate the client devices **220** and **230**, respectively, which may be the same or similar to the client devices **120** and **130** described above with respect to FIG. **1**. Similarly, user C may operate the client device **240**, which may be the same or similar to the client device **140**.

[0053] Following the above example for user B, user B may open an application, such as a chat card application **222** (e.g., an education-based collaboration application), to begin a chat card exercise, such as the chat card exercise **136**. To open the application **222**, the client device **230** may communicate with an application service **201**, which may be the same or similar to the application service **101**. The application service **201** may initiate and operate the chat card application **222** on the client device **230**. Once the application is open on the client device **230**, user B may begin a chat card exercise within the chat card application **222** by, for example, selecting a topic for the exercise and interacting with the respectively generated chat cards within the exercise.

[0054] As noted above, the chat card application **222** provides enhanced and conversational chat card exercises as generated by chat card engine **210**. The chat card engine **210** may be the same or similar to the chat card engine **110**. As such, in some embodiments, upon initiating the chat card application **222** on the client device **230**, software corresponding to the chat card engine **210** may also be initiated. That is, settings associated with the chat card application **222** may indicate a certain exercise is handled (e.g., generated and tracked) by the chat card engine **210**. For example, if user C is an educator, user C may have prepared a chat card exercise to be completed in the chat card application **222**. As part of the exercise, user C may have selected a setting to have the chat card engine **210** generate the chat cards within the exercise based on a source document provided by the user C for a student, here user B, to complete within a given time period. The user C may also select a setting to observe the completion of the exercise. As such, the chat card engine **110** generates the chat card exercise, including the chat cards within the chat card exercise, based on the source document provided by the user C, provides the chat card exercise to the user B, via the chat card application **222**, and generates a summary of the user B's performance on the chat card exercise.

[0055] In another scenario, the user B may generate the chat card exercise. As such, as part of preparing the exercise, the user B may provide a source document to the chat card engine **210**. The chat card engine **210** may generate the chat card exercise based on the source document provided by the user B and provide the chat cards within the exercise to the user B via the chat card application **222**. Since the user B generated the chat card exercise, the settings may indicate that no summary should be generated and provided to the user C. Depending on the circumstances, however, the user B or user C may select a setting to provide a summary of a personal chat card exercise to a reviewing user, such as user C. It should be appreciated that while the description provided herein includes a reviewing user, such as user C (e.g., an educator), the chat card engine **210** and the related chat card exercises may be generated and used without a reviewing user. That is, user B may use the chat card engine **210** outside of a classroom setting and generate chat card exercises to expand his or her knowledge within a personal capacity.

[0056] As noted above, after a student (e.g., user B) completes and submits the chat card exercise via the chat card application **222**, the chat card engine **210** may generate a report or summary of the chat card exercise. The report may indicate the subtopics that the student mastered and/or subtopics that require more attention within the chat card exercise. Additionally, the chat card engine **210** may generate a summary that provides metrics on user B's progress with respect to other students within a class. For example, the chat card engine **210** can generate a summary showing user B's accuracy on various topics in general or subtopics within a given exercise with respect to a class average or other students within his or her class. Reports and summaries generated by the chat card engine **210** are discussed in greater detail below, in particular, with respect to FIGS. **14-15**.

[0057] Turning now to FIG. **3**, a system **300** for providing a chat card engine **310** is illustrated, according to an embodiment herein. The system **300** includes the chat card engine **310** and a client device **330**, which may be the same or similar to the chat card engine **110** and the client device **130**, respectively. The chat card engine **310** provides enhanced and conversational chat card exercises for a student **350** of the client device **330**. For ease of discussion the user of the client device **330** is described as a student within an educational environment, however, it should be appreciated that

other scenarios are also contemplated, such as the student **350** using the chat card engine **310** in a personal capacity.

[0058] For case of explanation, FIG. **3** is described in combination with FIG. **4**. FIG. **4** illustrates a process **400** for providing the chat card engine **310** and its related functions, according to an embodiment herein. The process **400** may also be noted as the chat card engine process **400** herein. Although the process **400** is described with respect to components and elements of FIG. **3**, it should be appreciated the one or more steps of the process **400** may be executed or applied to components or elements of any other Figure provided herein.

[0059] To begin, the student **350** corresponding to the client device **330** starts a chat card exercise. For example, the client device **330** provides an indication, such as opening a chat card application **322**, to begin the chat card exercise. In some cases, the student **350**, once within the chat card application **322**, selects a chat card exercise to begin, as will be described in greater detail below with respect to FIG. **5**. Once the student **350** selects a topic or opens the chat card application **322**, the chat card engine **310** receives an indication to start a chat card exercise (**405**).

[0060] Responsive to receiving the indication to start a chat card exercise, the chat card engine **310** determines a source document **312** (**410**). That is, the chat card engine **310** determines a corresponding source document to the chat card exercise selected by the student **350**. For example, if the student **350** selects to start a chat card exercise on Photosynthesis, then the chat card engine **310** may determine a source document **312** corresponding to the Photosynthesis chat card exercise. Following this example, the chat card engine **310** may determine that the source document **312** corresponding to the Photosynthesis chat card exercise relates to a textbook uploaded by an educator. In another example, the chat card engine **310** may determine that the source document **312** was uploaded by the student **350**. As can be appreciated, the student **350** may provide the source document **312** to the chat card engine **310** to practice or learn a topic of interest.

[0061] As noted above, the source document **312** may be uploaded, linked, or otherwise provided to the chat card engine **310**. As can be appreciated, in scenarios where an educator or reviewing user provides the source document **312** to generate a chat card exercise for more than one student, then the chat card engine **310** may store the source document **312** or otherwise retain the source document **312** for generation of chat card exercises. For example, the chat card engine **310** may store the source document **312** in a database **314**. As the chat card engine **310** references the source document **312** to generate chat card exercises, the chat card engine **310** may call the source document **312** within the database **314**.

[0062] Once the source document **312** is determined, the chat card engine **310** generates the chat cards based on the source document (**415**). That is, the chat card engine **310** generates the chat cards for a given chat card exercise. As described above, a chat card exercise includes multiple chat cards, and the chat card exercise may be directed to a topic with each of the chat cards being directed to a subtopic falling under the broader topic of the chat card exercise. That is, if the topic of the chat card exercise is Photosynthesis, then the chat cards within that exercise may be directed to chlorophyll and photosynthetic pigments.

[0063] In some cases, the chat card engine **310** generates all the chat cards within the chat card exercise at a single time, while in other cases the chat card engine **310** generates each chat card as the student **350** progresses through the chat card exercise. In some cases, a combination of these techniques may be used. As will be described in greater detail below, each chat card includes a prompt, such as a question for the student **350** to answer on a subtopic. The student **350** may then interact with the chat card engine **310** in a variety of ways to explore and answer the prompt. That said, the chat card engine **310** may generate an initial prompt for each of the chat cards within the chat card exercise at an initial time, while additional prompts and responses are generated by the chat card engine **310** during the student's **350** interaction with each respective chat card. If the chat cards for a chat card exercise are generated at an initial time, they may be stored within the database **314** for recall at a later time.

[0064] Regardless, the chat card engine **310** generates a first prompt based on a first subtopic (**420**). That is, the chat card engine **310** generates a first prompt based on a first subtopic within the broader topic of the chat card exercise. In some embodiments, the chat card engine **310** includes a content generator **316** and the content generator **316** generates the first prompt for the first chat card. For example, the chat card engine **310** may provide the first subtopic to the content generator **316** based on the source document **312** requesting a first prompt for the first chat card within the chat card exercise. The content generator **316** may be a text-to-text generative model, such as an LLM, or may be a text-to-image generative model or a multimodal (e.g., text and images) generative model. Examples include generative pre-trained transformer models. Although only one content generator **316** is illustrated, it should be appreciated that the chat card engine **310** may include more than one content generator **316**, including different types of content generators **316**. Additionally, while the content generator **316** is illustrated as part of the chat card engine **310**, in some embodiments, the content generator **316** may be hosted separately from the chat card engine **310**, for example, by a third party.

[0065] When requesting the content generator **316** to generate the first prompt for the first chat card, the chat card engine **310** may provide one or more parameters to the content generator **316**. For example, parameters may include a task parameter that instructs the content generator **316** to act as an artificial intelligence (AI) tutor who is assisting a student in learning the information provided within the source document **312**. Other parameters may include action parameters, such as informing the content generator **316** that it can provide a hint or example if requested by the student, and off-topic parameters which instruct the chat card engine **310** to politely redirect a student back to the topic if a query is determined to be off-topic (e.g., not related to the topic or subtopic of the chat card). In some cases, the parameters also include conversational parameters which provide the structure for the content generator's **316** response. For example, conversational parameters may include a limit of one question at a time as well as various other structural limitations. The conversational and action parameters are described in greater detail below.

[0066] Once the first prompt is generated, the chat card engine **310** generates a first chat card including the first prompt (**425**). The first chat card may also be generated by

the content generator **316**. An example of the first chat card and its components therein are described in greater detail below with respect to FIGS. **5-13**.

[0067] Once generated, the chat card engine **310** provides the first chat card to the student **350**. For example, the chat card engine **310** may transmit the first chat card such that it is displayed via the chat card application **322** on the client device **330** to the student **350**. Upon receipt of the first chat card, the student **350** may provide a first query or response to the first prompt. As will be described in greater detail below, the student **350** may answer the first prompt, request an example, or ask for a hint. As can be appreciated, the student **350** may interact with the first chat card via the chat card application **322** in a variety of manners. For example, the student may use a mouse, keyboard, or digital stylus to respond to the first prompt with a first query. In another example, the student may use speech **302** to respond to the first prompt. As can be appreciated, the speech **302** may be captured by a microphone **304**. The microphone **304** may be part of the client device **330** or may be separate from the client device **330** but operably coupled to the client device **330** such to provide the speech **302** from the student **350** to the chat card application **322**.

[0068] Based on the student's **350** interaction with the first chat card, the chat card engine **310** receives the first query from the client device **350** (**430**). As noted above, the first query is made responsive to the first prompt and can include a variety of actions. For example, the first query may be a response to the first prompt, such as an answer to "what is photosynthesis," or the first query may be a request for a hint or an example. In some embodiments, the first query may be an off-topic query provided by the student **350**. For example, in response to the first prompt, the student **350** may ask the chat card engine **310** to tell a joke. Following corresponding off-topic parameters, the chat card engine **310** may determine that the first query is off topic (e.g., not related to the topic, here photosynthesis) and provide a redirecting prompt which guides the student **350** back to the topic at hand. For example, the chat card engine **310** may generate a redirection prompt that responds to the off-topic query with a joke but then ask the student **350** to answer the first prompt. Various examples of actions that could be included in a query provided by the student **350** responsive to a prompt are described with respect to FIGS. **5-13**.

[0069] Responsive to receiving the first query, the chat card engine **310** determines an understanding score (**435**). For example, the chat card engine **310** may include an understanding module **318** and the understanding module **318** may determine the understanding score based on the first query. For example, the understanding module **318** may be or include a content generator, such as an LLM. In such an example, the chat card engine **310** may provide the first query to the understanding module **318** and ask the understanding module **318** to rank the query based on the first prompt. As part of this request, the understanding module **318** may be provided with a scoring guide, such as a ranking scale. For example, the chat card engine **310** may provide an understanding scale of 1 to 3, indicating that a 1 score indicates that the student **350** does not understand the subtopic, a 3 score indicates that the student **350** understands the subtopic, and a 2 score indicates that more information is needed to determine whether the student **350** understands the subtopic. In some cases, when an understanding score determines that the student **350** understands the subtopic, this may be referred to herein as an advancing understanding. As can be appreciated, various understanding scales may be used and the understanding module **318** may be prompted in a variety of manners to generate an understanding score based on the first query.

[0070] In some cases, an interaction history within a given chat card may be provided as part of the request for an understanding score to the understanding module **318**. That is, if the student **350** and the chat card engine **310** have engaged in a conversation, having multiple prompts and queries exchanged within a given chat card, the understanding module **318** may be provided with that interaction history for determining an understanding score. The understanding module **318** may also be provided with the corresponding prompt, here the first prompt, when analyzing the query, here the first query, submitted by the student **350**.

[0071] Depending on the student's **350** understanding score for the first query, the chat card engine **310** generates a second prompt. If the chat card engine **310** determines, based on the understanding score, that the student **350** understands the subtopic, then the second prompt may be a celebratory or congratulatory prompt indicating that the student **350** answered the first prompt correctly. However, if the chat card engine **310** determines, based on the understanding score, that the student **350** does not understand the subtopic or more information is needed to make the determination, then the second prompt may be a follow-up request prompting the student **350** to explore the subtopic further. That is, the chat card engine **310** generates a second prompt based on the understanding score for the previous prompt and query exchange, here the first prompt and first query (**440**). Once generated, the second prompt is provided to the student **350** via the chat card application **322** for response (**445**).

[0072] Depending on the query to which the second prompt was generated, the content within the second prompt may vary. That is, if the first query is a request for a hint, then the second prompt may include the requested hint. The content generator **316** may generate the hint (e.g., the second prompt) based on the first prompt, first query, and the subtopic of the chat card. In other words, the content generator **316** may be requested to generate a hint based on the first prompt, the first query, and the subtopic of the chat card. In some cases, the interaction history between the student **350** and the chat card engine **310** may also be considered. As can be appreciated, by providing the interaction history, the content generator **316** can tailor the hint based on previous hints, prompts, queries, and examples provided to the student **350**.

[0073] As noted above, when generating a hint, the content generator **316** may be guided by hint parameters. Example hint parameters may include instructions such as "a hint should not tell the student the answer directly," "a hint is meant to trigger a cognitive process to assist the student in understanding the prompt," and "avoid hints that are too obvious or too general." In some cases, the hint parameters may also include an example of a hint to provide guidance to the content generator **316** during generation of the hint.

[0074] In some examples, instead of requesting a hint, the student may request an example or ask a question. As can be appreciated, the student may ask a variety of questions, such as requesting more information or requesting clarification (e.g., an exploratory query). For example, the student **350** may ask a thought-provoking question. Following the pho-

tosynthesis chat card example, the student **350** may ask the thought-provoking question of "could photosynthesis occur on other planets within the solar system?" As used herein, a thought-provoking question may be a question that stimulates critical thinking, challenges existing assumptions, or prompts deep reflection on a subtopic.

[0075] To respond to any query including a question or asking for an example, the chat card engine **310** may first determine whether a corresponding answer is within the source document **312**. For example, the chat card engine **310** may parse the source document **312** based on the query to determine whether an answer is within the source document **312**. If the chat card engine **310** determines that the source document **312** includes the answer, then the chat card engine **310**, in particular the content generator **316**, may generate a follow-up prompt including the answer to the query. When the answer is identified in the source document **312**, the chat card engine **310** may generate a citation to where the answer was found within the source document **312**. As can be appreciated, this may allow the student **350** to investigate the answer further by referencing the source document **312** using the citation.

[0076] In some cases, upon analyzing the source document **312** in view of the query, the chat card engine **310** may determine that the source document **312** does not include an answer to the query. For example, the chat card engine **310** may determine a query expansion requirement based on the source document **312** not containing an answer to the query. In particular, a query expansion module **324** may determine a query expansion requirement and then determine whether one or more external sources **326** includes an answer to the query. Examples of external sources **326** may include any material that is external to the source document **312**, such as other textbooks or lesson plans stored within the database **314** that may correspond to the subtopic at hand. Following the photosynthesis example question, the chat card engine **310** may search for other source documents saved in the database **314** that may relate to photosynthesis or biology to answer the query. In other examples, however, the external sources **326** may include web-based sources, such as online scholarly articles, information based websites (e.g., Wikipedia), or online textbooks.

[0077] In some cases, there may be a hierarchy in which the query expansion module **324** searches for an answer to a query. For example, the chat card engine **310** may first analyze the source document **312** for the answer. If the chat card engine **310** is unable to determine the answer within the source document **312**, the chat card engine **310** may direct the query expansion module **324** to search vetted external sources **328** for an answer. A vetted external source **328** may be an external source **326** that has been verified. A vetted external source **328** may be verified by a reviewing user, such as an educator, or may be determined by the chat card application **322** as a verified source, such as Wikipedia or scholar articles issued by the National Center for Biotechnology Information (NCBI). If an answer is determined within the vetted external source **328**, the prompt generated based on the answer may include a note indicating that the information included in the prompt is from an external source. However, because the answer is from the vetted external source **328**, the note may merely comment that the answer is from outside the learning material and from a verified external source. The prompt may also include a citation to the answer within the vetted external source **328**.

[0078] In some cases, if the query expansion module **324** is unable to determine the answer within the source document **312** or within the vetted external source **328**, then the query expansion module **324** may search for an answer within unvetted external sources **338**. Unvetted external sources **338** may be external sources that are not verified. For example, if the educator identifies Wikipedia and articles from NCBI as vetted external sources **328**, then if the query expansion module **324** searches outside of those sources, any other external source **326** may be determined to be an unvetted source **338**. For example, if the query expansion module **324** searches for an answer to the above thought-provoking query on photosynthesis and finds a blog post about the possibility of life on other planets within the solar system, the blog post is considered an unvetted external source **338**. In some cases, the unvetted external source **338** also includes any knowledge the chat card engine **310** identifies from within its model world knowledge. As those skilled in the art appreciate, the chat card engine **310**, in particular the content generator **316**, may be trained by feeding information into its model. That information forms the chat card engine's **310** model world knowledge.

[0079] When an answer is identified within an unvetted external source **338**, any prompt generated based on that answer includes a caution tag. The caution tag may note that the answer is external to the learning material and the student **350** should exercise caution in relying on the information. In some cases, the prompt may also include a citation to the answer within the unvetted external source **338**.

[0080] When the chat card engine **310** generates prompts, including the first prompt, the prompt may be provided to a quality assurance module **346**. The quality assurance module **346** may perform a validation process on any prompts generated by the chat card engine **310**. The validation process may include analyzing the prompts based on one or more quality parameters. For example, the quality assurance module **346** may include a schema validator **348** and a content moderator **352**. The schema validator **348** may perform a schema validation process in which the schema validator **348** analyzes a prompt generated by the content generator **316** prior to the chat engine **310** providing the prompt to the student **350**. In particular, the schema validator **348** may analyze the prompt based on one or more quality parameters, such as a length parameter, a coherency parameter, or pacing parameter. The length parameter may ensure that the prompt generator **316** is not beyond a sentence length, such as no prompt should be longer than 5 sentences. The coherency parameter may analyze the prompt to make sure all the content within the prompt is coherent. And the pacing parameter may analyze the prompt in view of the interaction history between the student **350** and the chat card engine **310** with the chat card to ensure that the prompt accurately matches the pace of the interaction. As can be appreciated, each student may vary in pacing when it comes to learning new material, and as such, the pacing parameter ensures that the prompt generated by the chat card engine **310** doesn't move the interaction too slow for the student **350** or push the student **350** too fast along in the learning process.

[0081] The content moderator **352** may perform a content moderation process in which the content moderator **354** analyzes the prompt based on the one or more quality parameters. In particular, the content moderator **352** may

analyze the prompt based on a content quality parameter, which may provide guides on what content is considered inappropriate content. Accordingly, the content quality parameter may analyze the content of the prompt to ensure that the prompt does not include inappropriate content, such as content that may violate ethical standards, hate speech, or any content that promotes harm or illegal activities.

[0082] In some cases, the quality assurance module **346** may generate a quality score based on the evaluation of the quality parameters and prompts that fall below a quality score threshold may be resubmitted to the content generator **316** with a request to improve the quality of the prompt. In some cases, the request to regenerate the prompt may include the identified quality parameter that scored low within the quality score.

[0083] As the student **350** progresses and eventually completes a chat card exercise, the chat card engine **310** may evaluate the student's **350** accuracy for each of the chat cards within the exercise. For example, if the student **350** is unable to answer a chat card correctly and eventually moves on to the next chat card, the chat card engine **310** may determine that the student did not accurately answer that chat card. However, the student **350** may answer each of the remaining chat cards correctly. As such, the chat card engine **310** may grade or otherwise generate a summary of the student's interaction with the chat card exercise. For example, the chat card engine **310** may include a grading module **354** that grades the student's **350** completion of the chat card exercise. The grading module **354** may determine whether the student **350** completed the chat card exercise, completed the chat card exercise by an exercise due date, how the student **350** performed during the chat card exercise, and the like. Performance of the student **350** during a given chat card exercise may include a number of exchanges between the student **350** and the chat card engine **310** until a correct answer was provided, how long it took for the student to complete a chat card exercise (e.g., it took the student **10** minutes to complete the exercise), and the accuracy of the student **350** on each of the chat cards within the chat card exercise.

[0084] The grading module **354** may also generate a report or summary of the student's **350** grade for the chat card exercise. The report or summary generated by the chat card engine **310** may be provided to an educator or reviewer. Such an example is described in greater detail below with respect to FIGS. **14-15**. As can be appreciated, by providing a summary of how the student interacted with the chat card exercise, the educator can evaluate what materials need to be covered in subsequent lessons and gather across all of the students within a given class where the class is with various topics and subtopics.

[0085] As noted above, in some cases the chat card engine **310** may generate and store chat card exercises within the database **314**. As can be appreciated, computing resource requirements may be reduced by retrieving previously generated chat card exercises, hints, examples, and answers, instead of generating this content for each student for every exercise. For example, if all the students within a biology class perform the chat card exercise on photosynthesis, then the chat card engine **310** may generate this chat card exercise once and store it within the database **314**. As each student within the class requests to start the exercise, the chat card engine **310** may retrieve the associated chat cards are provide them to the student. Similarly, answer, hints, and examples generated during an answer with one student may be stored and used if another student requests the same or similar information.

[0086] Once the student **350** provides a query containing a correct answer to the prompt, the chat card engine **310** may determine that the student understands the subtopic based on the understanding score. Responsive to determine that the student understands the subtopic, the chat card engine **310** may progress the chat card exercise to the next chat card. In other words, if the student **350** answers the prompt within the chat card correctly, then the chat card engine **310** generates or otherwise provides the next chat card within the exercise to the student via the chat card application **322**.

[0087] Turning now to FIG. **5**, an example chat card dashboard **500** is provided, according to an embodiment herein. For ease of discussion, the remaining FIGS. **5-15** are described with reference to FIG. **3**, however, it should be appreciated that other figures or components thereof may be equally applicable to the following discussion.

[0088] The chat card dashboard **500** may be provided to the student **350** via the chat card application **322**. For example, the student **350** may open the chat card application **322** and be provided with the chat card dashboard **500**. The chat card dashboard **500** includes a variety of chat card exercises **536**A-H, each directed to a different topic. For example, the chat card exercise **536**A is directed to Plate Tectonics, the chat card exercise **536**B is directed to Kinetic Energy, the chat card exercise **536**C is directed to Structure and Composition of the Atmosphere, the chat card exercise **536**D is directed to History of Ancient Egypt, the chat card exercise **536**E is directed to Astronomy **101**, the chat card exercise **536**F is directed to the Earth's Atmosphere, the chat card exercise **536**G is directed to Presidential Election Process, and the chat card exercise **536**G is directed to Intro to Photosynthesis. Since each of the chat card exercises are directed to a different topic, each chat card exercise may be generated by the chat card engine **310** based on a different source document **312**. In some cases, however, more than one chat card exercise may be generated based on the same source document **312**. For example, the chat card exercise **536**C may be generated based on a first chapter within the source document **312**, while the chat card exercise **536**G may be generated based on a third chapter within the source document **312**.

[0089] As illustrated, one or more of the chat card exercises **536**A-H may include a grade indicator **556**. The grade indicator **556** may indicate whether the student **350** completed the chat card exercise and with what accuracy the student **350** completed the corresponding chat card exercise. For example, the grade indicator **556** on the chat card exercise **536**B indicates that the student **350** completed the chat card exercise **536**B with a 72% accuracy, while the student **350** completed the chat card exercise **536**E with a 91% accuracy. As can be appreciated, the grading module **354** of the chat card engine **310** may generate the grade for each of the grade indicators **556**. If the chat card exercise does not include a grade indicator **556**, such as the chat card exercise **536**A or the chat card exercise **536**H, this may indicate that the student **350** has not completed the chat card exercise yet. To begin or complete a chat card exercise, such as the chat card exercise **536**H, the student **350** may select the chat card exercise **536**H with a cursor **558**.

[0090] Turning now to FIG. **6**, an example chat card **634** generated by the chat card engine **310** is illustrated, accord-

ing to an embodiment herein. The chat card **634** may be generated by the chat card engine **310** responsive to the student **350** selecting the chat card exercise **536**H. As such, the chat card **634** may be directed to a subtopic within the topic of Intro to Photosynthesis. As shown, the chat card **634** may include a dialogue body **660** in which prompts and queries are exchanged between the student **350** and the chat card engine **310**. For example, the dialogue body **660** includes a first prompt **662**. The first prompt **662** includes the question "What is photosynthesis?"

[0091] To respond to the first prompt **662**, the chat card **634** includes an input field **664** into which the student **350** may generate his or her response (e.g., query). As noted above, in some cases the student **350** may generate his or her response verbally. As such, the input field **664** may include a microphone option **666** for generating a response using speech **302**. In other cases, the student **350** may generate the response within the input field **664** by typing, writing, or otherwise generating text within the input field **664**. Once a response is generated within the input field **664**, the student **350** may select the submit option **668**. Upon submitting the response generated within the input field **664**, the response may be provided within the dialogue body **660** as a query (not shown) from the student **350**. Examples of a query generated within the dialogue body **660** are provided in the below examples.

[0092] The chat card **634** may also include a progress bar **670**. The progress bar **670** may indicate how many chat cards the student **350** has completed within the chat card exercise **536**H. For example, a first bar **672** is highlighted to indicate that the student **350** is on the first chat card **634** within the chat card exercise **536**H. As will be illustrated below, the progress bar **670** may also indicate which of the chat cards within the chat card exercise **536**H the student **350** completed correctly and which chat cards the student **350** incorrectly completed. In addition to or in place of the progress bar **670**, the chat card **634** may also include a counter **674** that indicates which chat card the student **350** is on within the chat card exercise **536**H.

[0093] The chat card **634** may also include a reviewer note **676** that indicates that that the student's **350** progress in the chat card exercise **536**H is to be shared with a reviewing user, here Deb Patil. Once the student **350** completes the chat card **634** or if the student **350** wants to go to the next chat card without completing the chat card **634**, the student **350** may select a next option **678**.

[0094] Instead of generating a response to the first prompt **662** within the input field **664**, the student **350** may select a hint request **680** or an "I don't know" option **682**. In some cases, instead of selecting the hint request **680** or the "I don't know" option **682**, the student **350** may type corresponding text into the input field **664** and the chat card engine **310** may generate a similar response.

[0095] Turning now to FIG. **7**, an example hint prompt generated by the chat card engine within chat card **634** of FIG. **6** is illustrated, according to an embodiment herein. That is, the student **350** may select the hint request **680** in FIG. **6** and a hint prompt **684** may be generated within the dialogue body **660**. As shown, responsive to selecting the hint request **680**, a hint query **681** may be generated within the dialogue body **660**. The hint query **681** may maintain its position within the dialogue body **660** as the student's **350** response to the first prompt **662**. By maintaining the position of the hint query **681** within the dialogue body **660**, a complete interaction history between the student **350** and the chat card engine **310** can be generated, showing how the student **350** responded to each prompt provided by the chat card engine **310**.

[0096] In some embodiments, an icon may be provided next to content generated by the chat card engine **310** to indicate what type of response the provided prompt is. For example, an AI tutor icon **686** may be provided next to the first prompt **662** since the first prompt **662** corresponds to the question part of the chat card **634**. For the hint prompt **684**, a hint icon **688** may be provided to indicate that the hint prompt **684** was generated responsive to the hint request **680**. As will be illustrated in the following Figures, the icon may vary depending on the type of prompt that is provided by the chat card engine **310**.

[0097] As shown, responsive to receiving the hint prompt **684**, the student **350** generated the query **690**. In the illustrated example, the query **690** may include the correct answer to the first prompt **662**. As described above, the chat card engine **310** may determine that the query **690** includes the correct answer by determining an understanding score for the query **690**. As should be apparent, the chat card engine **310** may have determined that the understanding score for the hint query **681** indicates that the student **350** doesn't understand the subtopic or more interaction is needed to determine the student's **350** understanding level. As such, the chat card engine **310** may respond with the hint prompt **684** and wait for additional queries, such as the query **690**, to determine whether the student **350** understands the subtopic.

[0098] Once the chat card engine **310** determines that the student **350** understands the subtopic (e.g., an advancing understanding is determined), based the corresponding understanding score for the query **690**, the chat card engine **310** may generate an indication that the student **350** provided the correct answer. Referring now to FIG. **8**, an example correct answer prompt **691** is illustrated, according to an embodiment. As shown, the correct answer prompt **691** is generated based on the student's **350** query **690** that includes the correct response. The correct answer prompt **691** may include a celebratory message, such as "Absolutely right!," to indicate that the student **350** answered correctly. In some cases, the correct answer prompt **691** may provide additional information on the correct answer, such as expanding on the query **690**. For the additional information included in the correct answer prompt **691**, the correct answer prompt **691** may also include a citation **692**. As noted above, when generating content for a prompt, the chat card engine **310** may include a citation to corresponding material in the source document **312** or the vetted external source **338**.

[0099] To indicate that the correct answer prompt **691** indicates a correct answer, a correct answer icon **693** may be provided proximate to the correct answer prompt **691** within the dialogue body **660**. Similar to the other icons described above, the correct answer icon **693** may provide a visual indication within the interaction answer of the chat card **634** of what type of prompts the chat card engine **310** provided. Following receiving the correct answer prompt **691**, the student **350** may continue to the next chat card via an option **694**, request an example via the option **682**, or request additional information via an option **695**. As illustrated, the student **350** selects the example option **682** and an example query **683** is generated within the dialogue body **660**.

[0100] Turning now to FIG. **9**, an example prompt **696** generated by the chat card engine **310** is illustrated, according to an embodiment herein. That is, the example prompt **696** may be generated responsive to the student **350** generating the example query **683** by selection of the example option **682**. Responsive to receiving the example query **683**, the chat card engine **310** may generate the example prompt **696**. For example, the chat card engine **310** may request the content generator **316** to generate an example of photosynthesis based on the interaction history between the student **350** and the chat card engine **310** within the dialogue body **660**. As such, the content generator **316** may analyze all the interactions within the dialogue body **660** and generate the example prompt **696**. Since the example prompt **696** is a different type of prompt, the example prompt **696** may include an example icon **697**. Additionally, the example prompt **696** may include a citation **692** to where material corresponding to the example can be found either in the source document **312** or the vetted external sources **328**.

[0101] Upon reviewing the example prompt **696**, the student **350** may want to explore photosynthesis further. As such, the student **350** may select option **695** or otherwise generate a query **696** requesting "food for thought." The query **696** may be an exploratory query that indicates that the student **350** wants more information on the subtopic or wants to explore the subtopic further.

[0102] Turning now to FIG. **10**, an example exploratory prompt **699** generated by the chat card engine is illustrated, according to an embodiment herein. The exploratory prompt **699** may be generated responsive to the chat card engine **310** receiving the query **696** from the student **350** requesting additional information on the topic. As illustrated, the exploratory prompt **699** may be in the form of a question meant to provoke the student **350** to think further on the subtopic. The exploratory prompt **699** includes an exploratory icon **621** and a citation **692** to where the corresponding material can be found.

[0103] In the illustrated example, upon review of the exploratory prompt **699**, the student **350** may determine that its time to proceed to the next chat card. Since the chat card engine **310** determined that the student **350** understands the subtopic, as indicated by the advancing understanding score determined for the query **690**, the chat card engine **310** may enable the student **350** to progress to the next chat card. In some cases, the student **350** can proceed to the next chat card without providing a correct answer indicating that he or she understands the subtopic, however, the chat card engine **310** may identify that chat card as an incorrect answer within the chat card exercise **536**H. To proceed to the next chat card, the student **350** may select the next option **678** with the cursor **558**.

[0104] Turning now to FIG. **11**, an example second chat card **1134** generated by the chat card engine **310** is illustrated, according to an embodiment herein. The second chat card **1134** may be generated responsive to the student **350** selecting the next option **678** on the chat card **634**. The second chat card **1134** may be the same as the chat card **634** except that it is directed to a different subtopic. For example, the second chat card **1134** includes a prompt **1162** asking about photosynthesis pigments, which is the subtopic of the second chat card **1134**, while the first prompt **662** of the chat card **634** asked generally about photosynthesis, which is the subtopic for the chat card **634**. Similar to the chat card **634**, the second chat card **1134** includes a dialogue body **1160** for displaying the interaction history between the student **350** and the chat card engine **310** within the second chat card **1134**.

[0105] The second chat card **1134** also includes an input field **1164** and a progress bar **1170**. As illustrated, since the second chat card **1134** is the second chat card within the chat card exercise **536**H, the progress bar **1170** includes a first bar **1172** and a second bar **1173** highlighted or otherwise visibly different from the remaining bars on the progress bar **1170** to indicate the student **350**'s progress. The second chat card **1134** also includes a counter **1174**, indicating that the student **350** is on the second chat card **1134**. As can be appreciated, the student **350** may interact with the second chat card **1134** until an understanding score is achieved indicating that the student **350** understands the subtopic. At this time, the student **350** may process to the next chat card within the chat card exercise **536**H. As noted above, the student **350** may also proceed to the next chat card without answering the chat card **1134** correctly, however, in such a case the chat card engine **310** may determine that the student **350** has incorrectly answered the chat card. In other words, if the chat card engine **310** does not determine an understanding score indicating that the student **350** understands the subtopic of the second chat card **1134** but the student **350** progresses to the next chat card anyways, the chat card engine **310** may mark the second chat card **1134** as incorrectly answered.

[0106] Turning now to FIG. **12**, an example final chat card **1234** within a chat card exercise is illustrated, according to an embodiment herein. The final chat card **1234** may be the same or similar to the chat cards **634** or **1134**, except it is directed to a different subtopic. As indicated by a prompt **1262**, the chat card **1234** is directed to the subtopic of "potential applications of photosynthesis." The student **350** may interact with the final chat card **1234** as described above until an understanding score indicating the student **350** understands the subtopic is determined by the chat card engine **310**. In other words, the student **350** may interact with the final chat card **1234** until he or she completes the final chat card **1234**.

[0107] As illustrated, the final chat card **1234** includes a progress bar **1270**. Since the student **350** has completed all of the chat cards within the chat card exercise **536**H, each of the bars **1272** within the progress bar **1270** are visually changed to indicate completion. In some cases, each of the bars **1272** are visually modified to indicate whether the student **350** completed the corresponding chat card correctly or incorrectly. For example, the bar **1275** may be a first color, indicating that the student **350** answered the corresponding chat card correctly, while the bar **1277** may be a second color to indicate that the student **350** answered the corresponding chat card incorrectly. Accordingly, the illustrated progress bar **1270** may indicate that the student **350** answered 17 of the chat cards correctly, while answering 3 of the chat cards incorrectly.

[0108] When the student **350** completes the chat card **1234**, the student **350** may select a finish option **1261**. Upon selection of the finish option **1261**, the chat card exercise **536**H may be marked as completed and the chat card engine **310** may generate a grade, for example by the grading module **354**, for the chat card exercise **536**H. If the student **350** wants to revisit any of the chat cards within the chat card exercise **536**H, the student **350** may select a back option **1279** to navigate to the desired chat card. In some cases, even once the chat card exercise **536**H is completed, the

student **350** may be able to navigate to already completed or skilled chat cards to revisit the material.

[0109] Turning now to FIG. **13**, a graphical user interface (GUI) **1300** providing a completion card **1363** for the chat card exercise **536**H is illustrated, according to an embodiment herein. As shown, the completion card **1363** includes an accuracy panel **1365**, a practice time panel **1367**, and a revisit panel **1369**. The accuracy panel **1365** may include a grade or otherwise include the accuracy at which the student **350** answered the chat cards within the chat card exercise **536**H. The practice time panel **1367** may include the time it took the student **350** to complete the chat card exercise **536**H, such as from start to finish. And the revisit panel **1369** may highlight subtopics or chat cards that the student **350** may wish to revisit. That is, the revisit panel **1369** may include the prompts from the chat cards that the student **350** answered incorrectly or that the interaction history indicated that the student **350** did not fully understand the subtopic. For example, the understanding score for one of the chat cards may have needed more information to determine whether the student **350** understood the subtopic but the student **350** selected to proceed to the next chat card without answering the prompt correctly.

[0110] The completion card **1363** may include an option **1371** to restart or revisit the chat card exercise **536**H. Upon selecting the option **1371**, the chat card exercise **536**H may restart. If the student **350** is done with the chat card exercise **536**H, then the student **350** may select option **1385** to complete and close the chat card exercise **536**H.

[0111] Beginning with FIG. **14**, FIG. **14** illustrates a GUI **1400** for providing metrics by student within a group across multiple chat card exercises, according to an embodiment herein. Specifically, the GUI **1400** illustrates a user interface **1442** that a reviewing user, such as an educator, may interact with. For example, the GUI **1400** may illustrate an example user interface **142**, as referenced in FIG. **1**, provided to user C via the client device **140**.

[0112] The user interface **1442** includes components associated with a chat card application (e.g., the chat card application **222** in FIG. **2**), including components **1451**, **1453**, **1455**, and **1457**. The component **1451** is representative of a main title bar that allows a reviewing user to, among other functions, open, close, minimize, or maximize user interface **1442**. The component **1451** includes a search box **1453** via which a user may input search queries with respect to content in the chat card application such as exercises, class lists, and class materials.

[0113] The component **1455** is representative of a feature bar that includes various icons for accessing modules of the application. For instance, the component **1455** includes an activity icon for checking alerts or reminders, a chat icon for chatting with other users, an icon for accessing team-oriented flows, an exercises icon for posting and reviewing exercises, a calendar icon for accessing a calendar feature, a call icon for placing voice calls, a files icon for managing files, and a store icon for accessing an app store. In some implementations, the component **1455** may include an icon for accessing a chat card engine, a chat card engine add-in application, or the like.

[0114] The app store—accessing via the store icon—provides the user with the ability to download and install "add-in" applications that are integrated into the context of the main application. Here, it is assumed for exemplary purposes that the user has installed a chat card engine through the store (or by another mechanism) or that the chat card application includes the chat card engine otherwise installed therein. As illustrated in FIG. **14**, the chat card engine can be loaded and executed in the context of another application, such as the chat card application **222** described with respect to FIG. **2**.

[0115] In the illustrated example, an educator may navigate to an exercise summary **1443**. The exercise summary **1443** may include a report **1445** for chat card exercises completed by students within a given group, such as a class. The report **1445** may be generated by a chat card engine, such as the chat card engine **110** or **310**. As illustrated, the report **1445** may provide an accuracy metric for each student within the group. As can be appreciated, the report **1445** may provide vital information to the educator on how well the students within a class are progressing or what needs to be revisited to aid the students with their learning process.

[0116] In an example embodiment, the educator may select a respective exercise, such as "Plate Tectonics" and be provided with metrics on how the class performed for each chat card within the Plate Tectonics exercise. In some cases, a class average for each chat card may be provided, while in other cases, metrics for how each student within the class performed on each chat card is provided. As can be appreciated, by providing the educator with the metrics for each chat card within a given exercise, the educator can better appreciate which questions or areas of the subject matter require further instruction.

[0117] In some embodiments, the educator may select a student using a cursor **1459** to view that student's metrics for each of the chat card exercises. Referring now to FIG. **15**, a GUI **1500** is provided illustrating metrics for a selected student across multiple chat card exercises, according to an embodiment herein. The GUI **1500** may be provided to a reviewing user, such as an educator, by an interface **1542**. The interface **1542** may include a summary **1543**. The summary **1543** may include a report **1545** which includes the selected student's performance on each of the assigned or completed chat card exercises.

[0118] From report **1545**, the educator can appreciate which concepts, such as Astronomy **101** or Thermodynamics, to focus future lessons on and what concepts the student understands. For example, from the report **1545**, the reviewing user can view accuracy metrics **1547** for each of the chat card exercises the student completed and view performance metrics **1549**. In the illustrated example, the performance metrics **1549** indicate how long it took the selected student to complete each of the chat card exercises. As can be appreciated, various metrics may be provided in the report **1545**.

[0119] Referring to FIG. **16**, FIG. **16** illustrates a computing system **1601** that may be used for providing a chat card engine and related functions, as described herein. For example, the client device **120** or **130** may be or include the computing system **1601**. As illustrated, the computing system **1601** includes a processing system **1602** that includes a microprocessor and other circuitry that retrieves and executes software **1605** from storage system **1603**. The processing system **1602** may be implemented within a single processing device but may also be distributed across multiple processing devices or sub-systems that cooperate in executing program instructions. Examples of the processing system **1602** include general purpose central processing units, graphical processing units, application specific pro-

cessors, and logic devices, as well as any other type of processing device, combinations, or variations thereof.

[0120] The storage system **1603** may comprise any computer readable storage media readable by processing system **1602** and capable of storing software **1605**. The storage system **1603** may include volatile and nonvolatile, removable and non-removable media implemented in any method or technology for storage of information, such as computer readable instructions, data structures, program modules, or other data. Examples of storage media include random access memory, read only memory, magnetic disks, optical disks, flash memory, virtual memory and non-virtual memory, magnetic cassettes, magnetic tape, magnetic disk storage or other magnetic storage devices, or any other suitable storage media. In no case is the computer readable storage media a propagated signal.

[0121] In addition to computer readable storage media, in some implementations the storage system **1603** may also include computer readable communication media over which at least some of the software **1605** may be communicated internally or externally. The storage system **1603** may be implemented as a single storage device but may also be implemented across multiple storage devices or subsystems co-located or distributed relative to each other. The storage system **1603** may comprise additional elements, such as a controller capable of communicating with the processing system **1602** or possibly other systems.

[0122] The software **1605** (including chat card engine process **1606**) may be implemented in program instructions and among other functions may, when executed by the processing system **1602**, direct the processing system **1602** to operate as described with respect to the various operational scenarios, sequences, and processes illustrated herein. For example, the software **1605** may include program instructions for implementing a chat card engine and related functions, as described herein.

[0123] In particular, the program instructions may include various components or modules that cooperate or otherwise interact to carry out the various processes and operational scenarios described herein. The various components or modules may be embodied in compiled or interpreted instructions, or in some other variation or combination of instructions. The various components or modules may be executed in a synchronous or asynchronous manner, serially or in parallel, in a single threaded environment or multithreaded, or in accordance with any other suitable execution paradigm, variation, or combination thereof. The software **1605** may include additional processes, programs, or components, such as operating system software, virtualization software, or other application software. The software **1605** may also comprise firmware or some other form of machine-readable processing instructions executable by the processing system **1602**.

[0124] In general, the software **1605** may, when loaded into the processing system **1602** and executed, transform a suitable apparatus, system, or device (of which computing system **1601** is representative) overall from a general-purpose computing system into a special-purpose computing system customized to generate features, functionality, and user experiences provided by the chat card engine. Indeed, encoding the software **1605** on the storage system **1603** may transform the physical structure of the storage system **1603**. The specific transformation of the physical structure may depend on various factors in different implementations of this description. Examples of such factors may include, but are not limited to, the technology used to implement the storage media of the storage system **1603** and whether the computer-storage media are characterized as primary or secondary storage, as well as other factors.

[0125] For example, if the computer readable storage media are implemented as semiconductor-based memory, the software **1605** may transform the physical state of the semiconductor memory when the program instructions are encoded therein, such as by transforming the state of transistors, capacitors, or other discrete circuit elements constituting the semiconductor memory. A similar transformation may occur with respect to magnetic or optical media. Other transformations of physical media are possible without departing from the scope of the present description, with the foregoing examples provided only to facilitate the present discussion.

[0126] Communication interface system **1607** may include communication connections and devices that allow for communication with other computing systems (not shown) over communication networks (not shown). Examples of connections and devices that together allow for inter-system communication may include network interface cards, antennas, power amplifiers, RF circuitry, transceivers, and other communication circuitry. The connections and devices may communicate over communication media to exchange communications with other computing systems or networks of systems, such as metal, glass, air, or any other suitable communication media. The aforementioned media, connections, and devices are well known and need not be discussed at length here.

[0127] Communication between the computing system **1601** and other computing systems (not shown), may occur over a communication network or networks and in accordance with various communication protocols, combinations of protocols, or variations thereof. Examples include intranets, internets, the Internet, local area networks, wide area networks, wireless networks, wired networks, virtual networks, software defined networks, data center buses and backplanes, or any other type of network, combination of network, or variation thereof. The aforementioned communication networks and protocols are well known and need not be discussed at length here.

[0128] While some examples of methods and systems herein are described in terms of software executing on various machines, the methods and systems may also be implemented as specifically-configured hardware, such as field-programmable gate array (FPGA) specifically to execute the various methods according to this disclosure. For example, examples can be implemented in digital electronic circuitry, or in computer hardware, firmware, software, or in a combination thereof. In one example, a device may include a processor or processors. The processor comprises a computer-readable medium, such as a random access memory (RAM) coupled to the processor. The processor executes computer-executable program instructions stored in memory, such as executing one or more computer programs. Such processors may comprise a microprocessor, a digital signal processor (DSP), an application-specific integrated circuit (ASIC), field programmable gate arrays (FPGAs), and state machines. Such processors may further comprise programmable electronic devices such as PLCs, programmable interrupt controllers (PICs), programmable logic devices (PLDs), programmable read-only memories

(PROMs), electronically programmable read-only memories (EPROMs or EEPROMs), or other similar devices.

[0129] Such processors may comprise, or may be in communication with, media, for example one or more non-transitory computer-readable media, which may store processor-executable instructions that, when executed by the processor, can cause the processor to perform methods according to this disclosure as carried out, or assisted, by a processor. Examples of may include, but are not limited to, an electronic, optical, magnetic, or other storage device capable of providing a processor, such as the processor in a web server, with processor-executable instructions. Other examples of non-transitory computer-readable media include, but are not limited to, a floppy disk, CD-ROM, magnetic disk, memory chip, ROM, RAM, ASIC, configured processor, all optical media, all magnetic tape or other magnetic media, or any other medium from which a computer processor can read. The processor, and the processing, described may be in one or more structures, and may be dispersed through one or more structures. The processor may comprise code to carry out methods (or parts of methods) according to this disclosure.

[0130] Examples are described herein in the context of systems and methods for providing a chat card engine and related functions. Those of ordinary skill in the art will realize that the foregoing description is illustrative only and is not intended to be in any way limiting. Reference is made in detail to implementations of examples as illustrated in the accompanying drawings. The same reference indicators will be used throughout the drawings and the following description to refer to the same or like items.

[0131] Additionally, the foregoing description of some examples has been presented only for the purpose of illustration and description and is not intended to be exhaustive or to limit the disclosure to the precise forms disclosed. Numerous modifications and adaptations thereof will be apparent to those skilled in the art without departing from the spirit and scope of the disclosure. In the interest of clarity, not all of the routine features of the examples described herein are shown and described. It will, of course, be appreciated that in the development of any such actual implementation, numerous implementation-specific decisions must be made in order to achieve the developer's specific goals, such as compliance with application-and business-related constraints, and that these specific goals will vary from one implementation to another and from one developer to another.

[0132] Reference herein to an example or implementation means that a particular feature, structure, operation, or other characteristic described in connection with the example may be included in at least one implementation of the disclosure. The disclosure is not restricted to the particular examples or implementations described as such. The appearance of the phrases "in one example," "in an example," "in one implementation," or "in an implementation," or variations of the same in various places in the specification does not necessarily refer to the same example or implementation. Any particular feature, structure, operation, or other characteristic described in this specification in relation to one example or implementation may be combined with other features, structures, operations, or other characteristics described in respect of any other example or implementation.

[0133] Use herein of the word "or" is intended to cover inclusive and exclusive OR conditions. In other words, A or B or C includes any or all of the following alternative combinations as appropriate for a particular usage: A alone; B alone; C alone; A and B only; A and C only; B and C only; and A and B and C.

Examples

[0134] These illustrative examples are mentioned not to limit or define the scope of this disclosure, but rather to provide examples to aid understanding thereof. Illustrative examples are discussed above in the Detailed Description, which provides further description. Advantages offered by various examples may be further understood by examining this specification.

[0135] As used below, any reference to a series of examples is to be understood as a reference to each of those examples disjunctively (e.g., "Examples 1-4" is to be understood as "Examples 1, 2, 3, or 4").

[0136] Example 1 is a system comprising: one or more computer readable storage media; one or more processors operatively coupled with the one or more computer readable storage media; and an application comprising program instructions stored on the one or more computer readable storage media that, when executed by the one or more processors, direct a computing system to at least: receive, from a client device, an indication to start a chat card exercise; determine, by a chat card engine, a source document based on the chat card exercise; generate, by the chat card engine, a plurality of chat cards based on the source document, wherein each of the plurality of chat cards correspond to a subtopic present in the source document; generate, by the chat card engine, a first prompt based on a first subtopic; generate, by the chat card engine, a first chat card comprising the first prompt; receive, by the chat card engine, a first query from the client device responsive to the first prompt; determine, by the chat card engine, an understanding score based on the first query; generate, by the chat card engine, a second prompt based on the understanding score; and provide, by the chat card engine, the second prompt to the client device on the first chat card.

[0137] Example 2 is the system of any previous or subsequent Example, wherein the program instructions to generate, by the chat card engine, the plurality of chat cards based on the source document cause, when executed by the one or more processors, to further direct the computing system to: generate, by the chat card engine, a question prompt and a corresponding answer prompt for each respective chat card within the plurality of chat cards, wherein the first prompt comprises a respective question prompt for the first chat card.

[0138] Example 3 is the system of any previous or subsequent Example, wherein the program instructions further direct the computing system to: determine, by the chat card engine, a type of query based on the first query; and generate, by the chat card engine, the second prompt based on the type of query and the understanding score, wherein the type of query comprises: an example query, an off-topic query, an exploratory query, and a hint request query.

[0139] Example 4 is the system of any previous or subsequent Example, wherein the program instructions further direct the computing system to: determine, by the chat card engine, a query expansion requirement based on the first query; retrieve, by the chat card engine, respective content from an external source based on the first query, wherein the respective content corresponds to the first subtopic and the

first query; generate, by the chat card engine, a citation to the respective content within the external source; and generate, by the chat card engine, the second prompt based on the respective content and the understanding score, wherein the second prompt comprises the citation.

[0140] Example 5 is the system of any previous or subsequent Example, wherein the program instructions to determine, by the chat card engine, the understanding score based on the first query cause, when executed by the one or more processors, the program instructions to further direct the computing system to: determine, by an understanding module, the understanding score based on an interaction history between the client device and the chat card engine within the first chat card and the first subtopic of the first chat card.

[0141] Example 6 is the system of any previous or subsequent Example, wherein the second prompt comprises content relating to the subtopic from the source document; and the program instructions further direct the computing system to generate, by the chat card engine, a citation to the content within the source document.

[0142] Example 7 is a method comprising: receiving, from a client device, an indication to start a chat card exercise; determining, by a chat card engine, a source document based on the chat card exercise; generating, by the chat card engine, a plurality of chat cards based on the source document, wherein each of the plurality of chat cards correspond to subtopic present in the source document; generating, by the chat card engine, a first prompt based on a first subtopic; providing, by the chat card engine, a first chat card comprising the first prompt to the client device, wherein the plurality of chat cards comprises the first chat card; receiving, by the chat card engine, a first query from the client device responsive to the first prompt; determining, by the chat card engine, an understanding score based on the first query; generating, by the chat card engine, a second prompt based on the understanding score; and providing, by the chat card engine, the second prompt to the client device on the first chat card.

[0143] Example 8 is the method of any previous or subsequent Example, wherein: generating, by the chat card engine, the plurality of chat cards based on the source document further comprises: generating, by the chat card engine, a question prompt and an answer prompt for each respective chat card within the plurality of chat cards, wherein the first prompt comprises a respective question prompt for the first chat card; and determining, by the chat card engine, the understanding score based on the first query comprises: comparing, by the chat card engine, the first query to a corresponding answer prompt to the first prompt; and determining, by the chat card engine, the understanding score based on the comparison of the first query to the corresponding answer prompt for the first chat card.

[0144] Example 9 is the method of any previous or subsequent Example, the method further comprising: determining, by the chat card engine, a query expansion requirement based on the first query; retrieving, by the chat card engine, respective content from an external source based on the first query, wherein the respective content corresponds to the first subtopic and the first query; and generating, by the chat card engine, the second prompt based on the respective content and the understanding score.

[0145] Example 10 is the method of any previous or subsequent Example, the method further comprising: performing, by the chat card engine, a validation process on the second prompt prior to providing the second prompt to the client device, wherein the validation process comprises a content moderation process and a schema validation process.

[0146] Example 11 is the method of any previous or subsequent Example, the method further comprising: receiving, by the chat card engine, a hint query from the client device; and generating, by the chat card engine, a hint responsive to the hint query, wherein the hint is based on the first subtopic and an interaction history between the client device and the chat card engine within the first chat card.

[0147] Example 12 is the method of any previous or subsequent Example, the method further comprising: receiving, by the chat card engine, a second query from the client device responsive to the second prompt; determining, by the chat card engine, a second understanding score based on the second query; generating, by the chat card engine, a third prompt based on the understanding score; and providing, by the chat card engine, the third prompt to the client device on the first chat card.

[0148] Example 13 is the method of any previous or subsequent Example, wherein the understanding score is determined to be an advancing understanding, and the method further comprises: generating, by the chat card engine, a third prompt based on a second subtopic; generating, by the chat card engine, a second chat card comprising the third prompt; receiving, by the chat card engine, a second query from the client device responsive to the third prompt; determining, by the chat card engine, a second understanding score based on the second query; generating, by the chat card engine, a fourth prompt based on the second understanding score; and providing, by the chat card engine, the fourth prompt to the client device on the second chat card.

[0149] Example 14 is the method of any previous or subsequent Example, the method further comprising: determining, by the chat card engine, an understanding score for each of the plurality of chat card; and generating, by the chat card engine, a grade for the chat card exercise based on the understanding score for each of the plurality of chat cards within the chat card exercise.

[0150] Example 15 is a computer readable storage media comprising processor-executable instructions configured to cause one or more processors to: receive, from a client device, an indication to start a chat card exercise; determine, by a chat card engine, a source document based on the chat card exercise; generate, by the chat card engine, a plurality of chat cards based on the source document, wherein each of the plurality of chat cards correspond to a subtopic present in the source document; generate, by the chat card engine, a first prompt based on a first subtopic; generate, by the chat card engine, a first chat card comprising the first prompt; receive, by the chat card engine, a first query from the client device responsive to the first prompt; determine, by the chat card engine, an understanding score based on the first query; generate, by the chat card engine, a second prompt based on the understanding score; and provide, by the chat card engine, the second prompt to the client device on the first chat card.

[0151] Example 16 is the computer readable storage media of any previous or subsequent Example, wherein: the processor-executable instructions to generate, by the chat card engine, the plurality of chat cards based on the source document cause the one or more processors to further execute processor-executable instructions stored in the com-

puter readable storage media to: generate, by the chat card engine, a question prompt and an answer prompt for each respective chat card within the plurality of chat cards, wherein the first prompt comprises a respective question prompt for the first chat card; and the processor-executable instructions to determine, by the chat card engine, the understanding score based on the first query cause the one or more processors to further execute processor-executable instructions stored in the computer readable storage media to: compare, by the chat card engine, the first query to a corresponding answer prompt to the first prompt; determine, by the chat card engine, a query expansion requirement based on the comparison of the first query to the corresponding answer prompt for the first chat card; retrieve, by the chat card engine, respective content from an external source based on the first query based on the query expansion requirement, wherein the respective content corresponds to the first subtopic and the first query; and compare, by the chat card engine, the first query to the respective content from the external source.

[0152] Example 17 is the computer readable storage media of any previous or subsequent Example, wherein the processor-executable instructions cause the one or more processors to further execute processor-executable instructions stored in the computer readable storage media to: perform, by the chat card engine, a validation process on the second prompt prior to providing the second prompt to the client device, wherein the validation process comprises one or more quality metrics.

[0153] Example 18 is the computer readable storage media of any previous or subsequent Example, wherein the processor-executable instructions cause the one or more processors to further execute processor-executable instructions stored in the computer readable storage media to: determine, by the chat card engine, an understanding score for each of the plurality of chat cards within the chat card exercise; and determine, by the chat card engine, a grade the chat card exercise based on the understanding score for each of the plurality of chat cards.

[0154] Example 19 is the computer readable storage media of any previous or subsequent Example, wherein: the processor-executable instructions cause the one or more processors to further execute processor-executable instructions stored in the computer readable storage media to: determine, by the chat card engine, that the first query is an off-topic query; and the processor-executable instructions to generate, by the chat card engine, the second prompt cause the one or more processors to further execute processor-executable instructions stored in the computer readable storage media to: generate, by the chat card engine, a redirecting prompt, wherein the redirecting prompt comprises content relating to the first subtopic.

[0155] Example 20 is the computer readable storage media of any previous or subsequent Example, wherein the processor-executable instructions cause the one or more processors to further execute processor-executable instructions stored in the computer readable storage media to: determine, by the chat card engine, a query expansion requirement based on the first query; retrieve, by the chat card engine, respective content from an external source based on the first query, wherein the respective content corresponds to the first subtopic and the first query; and generate, by the chat card engine, the second prompt based on the respective content and the understanding score.

What is claimed is:

1. A system comprising:
- one or more computer readable storage media;
- one or more processors operatively coupled with the one or more computer readable storage media; and
- an application comprising program instructions stored on the one or more computer readable storage media that, when executed by the one or more processors, direct a computing system to at least:
  - receive, from a client device, an indication to start a chat card exercise;
  - determine, by a chat card engine, a source document based on the chat card exercise;
  - generate, by the chat card engine, a plurality of chat cards based on the source document, wherein each of the plurality of chat cards correspond to a subtopic present in the source document;
  - generate, by the chat card engine, a first prompt based on a first subtopic;
  - generate, by the chat card engine, a first chat card comprising the first prompt;
  - receive, by the chat card engine, a first query from the client device responsive to the first prompt;
  - determine, by the chat card engine, an understanding score based on the first query;
  - generate, by the chat card engine, a second prompt based on the understanding score; and
  - provide, by the chat card engine, the second prompt to the client device on the first chat card.

2. The system of claim **1**, wherein the program instructions to generate, by the chat card engine, the plurality of chat cards based on the source document cause, when executed by the one or more processors, to further direct the computing system to:
- generate, by the chat card engine, a question prompt and a corresponding answer prompt for each respective chat card within the plurality of chat cards, wherein the first prompt comprises a respective question prompt for the first chat card.

3. The system of claim **1**, wherein the program instructions further direct the computing system to:
- determine, by the chat card engine, a type of query based on the first query; and
- generate, by the chat card engine, the second prompt based on the type of query and the understanding score, wherein the type of query comprises: an example query, an off-topic query, an exploratory query, and a hint request query.

4. The system of claim **1**, wherein the program instructions further direct the computing system to:
- determine, by the chat card engine, a query expansion requirement based on the first query;
- retrieve, by the chat card engine, respective content from an external source based on the first query, wherein the respective content corresponds to the first subtopic and the first query;
- generate, by the chat card engine, a citation to the respective content within the external source; and
- generate, by the chat card engine, the second prompt based on the respective content and the understanding score, wherein the second prompt comprises the citation.

5. The system of claim **1**, wherein the program instructions to determine, by the chat card engine, the understand-

ing score based on the first query cause, when executed by the one or more processors, the program instructions to further direct the computing system to:

determine, by an understanding module, the understanding score based on an interaction history between the client device and the chat card engine within the first chat card and the first subtopic of the first chat card.

6. The system of claim **1**, wherein the second prompt comprises content relating to the subtopic from the source document; and

the program instructions further direct the computing system to generate, by the chat card engine, a citation to the content within the source document.

7. A method comprising:

receiving, from a client device, an indication to start a chat card exercise;

determining, by a chat card engine, a source document based on the chat card exercise;

generating, by the chat card engine, a plurality of chat cards based on the source document, wherein each of the plurality of chat cards correspond to subtopic present in the source document;

generating, by the chat card engine, a first prompt based on a first subtopic;

providing, by the chat card engine, a first chat card comprising the first prompt to the client device, wherein the plurality of chat cards comprises the first chat card;

receiving, by the chat card engine, a first query from the client device responsive to the first prompt;

determining, by the chat card engine, an understanding score based on the first query;

generating, by the chat card engine, a second prompt based on the understanding score; and

providing, by the chat card engine, the second prompt to the client device on the first chat card.

8. The method of claim **7**, wherein:

generating, by the chat card engine, the plurality of chat cards based on the source document further comprises:

generating, by the chat card engine, a question prompt and an answer prompt for each respective chat card within the plurality of chat cards, wherein the first prompt comprises a respective question prompt for the first chat card; and

determining, by the chat card engine, the understanding score based on the first query comprises:

comparing, by the chat card engine, the first query to a corresponding answer prompt to the first prompt; and

determining, by the chat card engine, the understanding score based on the comparison of the first query to the corresponding answer prompt for the first chat card.

9. The method of claim **7**, the method further comprising:

determining, by the chat card engine, a query expansion requirement based on the first query;

retrieving, by the chat card engine, respective content from an external source based on the first query, wherein the respective content corresponds to the first subtopic and the first query; and

generating, by the chat card engine, the second prompt based on the respective content and the understanding score.

10. The method of claim **7**, the method further comprising:

performing, by the chat card engine, a validation process on the second prompt prior to providing the second prompt to the client device, wherein the validation process comprises a content moderation process and a schema validation process.

11. The method of claim **7**, the method further comprising:

receiving, by the chat card engine, a hint query from the client device; and

generating, by the chat card engine, a hint responsive to the hint query, wherein the hint is based on the first subtopic and an interaction history between the client device and the chat card engine within the first chat card.

12. The method of claim **7**, the method further comprising:

receiving, by the chat card engine, a second query from the client device responsive to the second prompt;

determining, by the chat card engine, a second understanding score based on the second query;

generating, by the chat card engine, a third prompt based on the understanding score; and

providing, by the chat card engine, the third prompt to the client device on the first chat card.

13. The method of claim **7**, wherein the understanding score is determined to be an advancing understanding, and the method further comprises:

generating, by the chat card engine, a third prompt based on a second subtopic;

generating, by the chat card engine, a second chat card comprising the third prompt;

receiving, by the chat card engine, a second query from the client device responsive to the third prompt;

determining, by the chat card engine, a second understanding score based on the second query;

generating, by the chat card engine, a fourth prompt based on the second understanding score; and

providing, by the chat card engine, the fourth prompt to the client device on the second chat card.

14. The method of claim **7**, the method further comprising:

determining, by the chat card engine, an understanding score for each of the plurality of chat card; and

generating, by the chat card engine, a grade for the chat card exercise based on the understanding score for each of the plurality of chat cards within the chat card exercise.

15. A computer readable storage media comprising processor-executable instructions configured to cause one or more processors to:

receive, from a client device, an indication to start a chat card exercise;

determine, by a chat card engine, a source document based on the chat card exercise;

generate, by the chat card engine, a plurality of chat cards based on the source document, wherein each of the plurality of chat cards correspond to a subtopic present in the source document;

generate, by the chat card engine, a first prompt based on a first subtopic;

generate, by the chat card engine, a first chat card comprising the first prompt;

receive, by the chat card engine, a first query from the client device responsive to the first prompt;

determine, by the chat card engine, an understanding score based on the first query;

generate, by the chat card engine, a second prompt based on the understanding score; and

provide, by the chat card engine, the second prompt to the client device on the first chat card.

16. The computer readable storage media of claim **15**, wherein:

the processor-executable instructions to generate, by the chat card engine, the plurality of chat cards based on the source document cause the one or more processors to further execute processor-executable instructions stored in the computer readable storage media to:

generate, by the chat card engine, a question prompt and an answer prompt for each respective chat card within the plurality of chat cards, wherein the first prompt comprises a respective question prompt for the first chat card; and

the processor-executable instructions to determine, by the chat card engine, the understanding score based on the first query cause the one or more processors to further execute processor-executable instructions stored in the computer readable storage media to:

compare, by the chat card engine, the first query to a corresponding answer prompt to the first prompt;

determine, by the chat card engine, a query expansion requirement based on the comparison of the first query to the corresponding answer prompt for the first chat card;

retrieve, by the chat card engine, respective content from an external source based on the first query based on the query expansion requirement, wherein the respective content corresponds to the first subtopic and the first query; and

compare, by the chat card engine, the first query to the respective content from the external source.

17. The computer readable storage media of claim **15**, wherein the processor-executable instructions cause the one or more processors to further execute processor-executable instructions stored in the computer readable storage media to:

perform, by the chat card engine, a validation process on the second prompt prior to providing the second prompt to the client device, wherein the validation process comprises one or more quality metrics.

18. The computer readable storage media of claim **15**, wherein the processor-executable instructions cause the one or more processors to further execute processor-executable instructions stored in the computer readable storage media to:

determine, by the chat card engine, an understanding score for each of the plurality of chat cards within the chat card exercise; and

determine, by the chat card engine, a grade the chat card exercise based on the understanding score for each of the plurality of chat cards.

19. The computer readable storage media of claim **15**, wherein:

the processor-executable instructions cause the one or more processors to further execute processor-executable instructions stored in the computer readable storage media to:

determine, by the chat card engine, that the first query is an off-topic query; and

the processor-executable instructions to generate, by the chat card engine, the second prompt cause the one or more processors to further execute processor-executable instructions stored in the computer readable storage media to:

generate, by the chat card engine, a redirecting prompt, wherein the redirecting prompt comprises content relating to the first subtopic.

20. The computer readable storage media of claim **15**, wherein the processor-executable instructions cause the one or more processors to further execute processor-executable instructions stored in the computer readable storage media to:

determine, by the chat card engine, a query expansion requirement based on the first query;

retrieve, by the chat card engine, respective content from an external source based on the first query, wherein the respective content corresponds to the first subtopic and the first query; and

generate, by the chat card engine, the second prompt based on the respective content and the understanding score.

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