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Analyzing Apps for Content-Area Literacy Attributes: An Exploratory Study

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Abstract

The development of mobile technologies such as iPads created the fastest growing technology trend in history, playing a significant role in personal, professional, and educational life. The focus of this exploratory study is the effective use of iPads and app technology in content classrooms. A checklist was developed that educators could use with ease when selecting apps that may help to develop students' content-area literacy skills.

The development of mobile technologies, a class of devices that includes tablets and smart phones, created what some have called an historically fast growing trend in technology to date with a substantial projected increase in the number of people using them (Basenese, 2011). Today, these devices play a significant role in personal, professional, and educational life. They are so pervasive for several reasons, chief of which are the sheer number of applications, more commonly known as *apps,* available for mobile devices as well as how customizable these devices can be through the use of apps. The simplified process for installing software due to apps also created a boom in the ways educational technology (edtech) can be used in today's classrooms (Clarke & Svanaes, 2014).This impact on student learning is unmatched, representing a multibillion-dollar industry (Chen, 2015; Richards & Stebbins, 2014).

One device, the iPad (a popular Apple tablet), has had an unprecedented impact on both the personal and educational markets since its release in 2010. In education, the iPad's impact is reflected in an increasing number of school districts adopting 1:1 technology initiatives that aim to equip all teachers and students with a mobile device (Project Tomorrow, 2014). With the robust functionalities the iPad offers, teachers are using these devices to implement blended learning lessons in the classroom (Hutchinson, Beschorner, & Schmidt-Crawford, 2012; Hutchinson & Colwell, 2012; Meurant, 2010). According to EdSurge (2013), over 4.5 million iPads are being used in classrooms in the United States. Unfortunately, not all teachers and students are able to access iPads or other mobile devices as a resource (Fink, 2003).

At the same time edTech has become more accessible in schools, there has been a national emphasis placed on preparing students to be successful in college and the workforce (National Center for Public Policy and Higher Education, 2010). A substantial component of that emphasis is that students develop digital literacy skills to be competent users of word processing and presentation programs, be able to evaluate online information for credibility, and use technology for collaboration (Law, Niederhauser, Christensen, & Shear, 2016; Dede, 2010).

Likewise, an emphasis is now placed on all teachers teaching literacy skills across every discipline. Content-area literacy focuses on the ability to use reading and writing to learn the subject matter of a discipline, but the emphasis is on a set of study skills that can be generalized across content areas (Shanahan, T. & Shanahan, 2012). Examples of this include the use of strategies such as monitoring comprehension, setting a purpose for reading, generating questions, summarizing, and making inferences. These strategies can be used across content areas easily as they are not discipline or grade level specific.

The call for K-12 students to develop 21st century technology and content-area literacy skills during their compulsory education is still relatively new. Though it is an emerging field, researchers have already studied methods for using apps to develop students' literacy skills (Freeman, Dragnic-Cindric, Reyes, & Anderson, 2017; Pettit, Bertrand, Fleming, & Jones, 2016). As well, educators across the disciplines are developing methods to integrate these skills into their instruction while continuing to teach their subject area's content, and it is in that work our study is situated. Though a tremendous number of educational apps are available (EdSurge, 2013; Banister, 2010), we know the quality of apps differs and researchers have developed a handful of rubrics to use when evaluating them (Cherner, Lee, Fegely, & Santaniello, 2016; Lee & Cherner, 2015; Walker, 2011).

The purpose of this study was to develop a checklist that educators could use with ease when selecting apps that focus on students' content-area literacy skills. To present the checklist, the methodology used to create it will be explained first. Next, findings including items from the checklist and apps that are representative of its different dimensions are presented. The article will conclude by discussing implications for how classroom teachers can use the checklist along with suggestions for future research projects based on the checklist.

Methodology

To create the checklist, a search was conducted of the Google Scholar (www.scholar.google.com) and Educational Resources Information Center (www.eric.ed.gov) to identify salient descriptors of characteristics commonly included in content-area texts. To identify these attributes, search terms included "content-area texts" coupled individually with a

broad group of search terms, such as *features of*, *descriptions include*, and *characteristics of* among others. These searches resulted in a small group of articles that described the texts used for content-area literacy. Summary statements about content-area texts based on these articles were then written and, from them, questions that became the checklist's items were formed. This alignment of summary statements and checklist items is shown in Table 1.

Table 1

A Checklist for Analyzing Apps for Content-Area Literacy Attributes

Checklist Item	**Summary Statements**
1. Do the texts used in the app teach subject specific knowledge?	During the upper-elementary grades, students transition from learning to read to reading to learn. Texts used at this stage promote students learning subject specific knowledge through the act of reading and comprehension exercises.
2. Does the app use text that is appropriate for a specific course and/or group of students?	Because content-area literacy texts are designed to teach specific contexts (e.g., 10^{th} grade biology, 9^{th} grade world literature, etc.), it is important that a text is written for a specific target learner and subject area.
3. Does the information presented in the app take the form of lettered and non-lettered texts (e.g., graphs, images, numbers, etc.)?	A traditional understanding of content-area literacy limits texts to be lettered pieces of writing that communicate a message. A more holistic approach to literacy recognizes texts take the form of both lettered and non-lettered messages. Students need to be able to comprehend these different types of messages if they are to read and learn from texts specific for different content areas.
4. Can general comprehension strategies be used to read, engage, and understand the text?	Though a text may be written for a specific subject area, the text can be analyzed using generic reading strategies that are not subject specific (e.g., Frayer Boxes, graphic organizers, summarization exercises).

With the framework for the checklist in place, the checklist's usability was tested by having content-area experts and teacher educators use it to evaluate subject-specific apps. To recruit experts for this study, professional connections within one major research university were used in a convenience sampling to contact both the content-area experts and teacher educators. All of these individuals taught classes at that university, held a terminal degree in their respective fields, and had access to an iPad, which they would need to complete the evaluation.

To locate apps to be evaluated by this checklist, apps were identified that content-area teachers might find online and use in their classrooms. For an app to be included in this study, it first had to be designed for the iPad and be free to download and install. To find these apps, the Google search engine (www.google.com) was used. The search terms used to find the apps were the name of a content area along with *high school* written inside quotes marks. The four search terms used to find apps were: (1) "high school" and "social studies," (2) "high school" and "math," (3) "high school" and "literature," and (4) "high school" and "science."

To further narrow down the pool, apps that were designed strictly for test preparation, to promote an event (e.g., a professional conference or publication), or that focused on a specific student subgroup (e.g., English language learners, students with disabilities, etc.) were not

included. Also, any apps that were open ended and allowed for teachers and/or students to generate their own content were not included since the quality of these apps may change significantly according to the content generated by users. From this pool of apps (*n*=537), the list of apps was narrowed for each content-area being investigated (e.g., literature, math, science, and social studies) based on the closest match for relevance in the Google search engine (e.g., top ten apps listed; see Table 2). Experts and teacher educators were then asked to evaluate the top two apps in each content-area using the checklist.

Table 2

Top Ten Apps Identified as Most Relevant by Content-Area

Content Area	**Top Ten Apps Identified as Most Relevant**
Science Search Term: "high school" and science; 130 apps reported	Bozeman Science Science Glossary The Journal Science CK-12: The Fun & Free Way to Learn Math & Science Brilliant.org Discovery Education TechBook Eureka.in Nuten – The Math and Science Keyboard Click and Learn on the App Store Encyclopedia of Biology
English / Literature Search Term: "high school" and literature; 145 apps reported	Literature Video tutorials by StudyStorm Lit Up! English literature on the App Store Wordly Wise 3000 Lexica Vol. 3 iGE Lite Macbeth Learning Guide Can You Name It? Lite Edition. Barron's EZ-101 Study Keys" English Literature Video – The Scarlet Letter Study Guide for the iPad Clean Slate: Hamlet HD
Mathematics Search Term: "high school" and math; 143 apps reported	Graphing Calculator Manuals: TI-84 Plus, TI-Nspire CX, CASIO fx-9860GII Math Math 42 WileD Math High School Math King of Math Kendall Hunt Common Core Math Math Exponents Mathway TowerStorm for Math and Literacy
Social Studies Search Term: "high school" and social studies; 119 apps reported	Best of Texas of Social Studies Economics myFlashcard Maker Discovery Education Techbook J's Flashcards Regions of America myFlashcard Maker Prentice Hall Brief Review of Global History & Geography TapQuiz Maps World Edition World History Games DynaNotes Plus BrainPop Featured Movie

After the app evaluations were complete, the data supplied was analyzed, looking for agreements and disagreements. If both the expert and teacher educator indicated that the app included the attributes that aligned to text used in content-area literacy, the app was recorded as being an exemplar of those traits. If only one or neither of the experts or teacher educators indicated the app had a trait needed to be used by texts in content-area literacy, that app was not said to be an "exemplar" of that attribute.

Findings

In this section, each question from the checklist is presented along with a summarization of the scholarship used to support it by sharing an app that content experts and teacher educators identified as containing those attributes. Interestingly, the experts and teacher educators only identified one app from this sample of eight apps (two for each of four content areas) as containing all the attributes on the checklist for texts used in content area literacy.

Checklist Item #1: Do the Texts Used in the App Teach Subject Specific Knowledge?

Typically, subject specific knowledge is the actual content of a discipline that includes its major theories, significant figures, epistemological roots, and key interpretations, facts, and perspectives (Mishra & Koehler, 2009). In the context of educational apps, however, this notion of knowledge differs because educational apps are not only intended to include the subject specific knowledge, but they must also contain characteristics for teaching that knowledge. Therefore, we adopted the definition used by Harris, Mishra, and Koehler (2009) for *pedagogical content knowledge* (PCK) because "it [PCK] covers essential knowledge of teaching and learning content-based curricula, as well as assessment and reporting of that learning" (p. 398). If an app is to be used to further student understanding of a topic, it needs to be developed in a way that teachers can blend it into their instruction, which includes not only the dissemination of knowledge but also the ability to assess student learning. In addition, scholars have found benefits in developing students' content-area literacy skills using a variety of texts (Johnson, Watson, Delahunty, McSwiggen, & Smith, 2011; Moje, Overby, Tysvaer, & Morris, 2008), and these texts may include articles, images, videos, and other representations of information displayed digitally, such as in apps. As a result, apps that contained multiple types of texts while incorporating both implications for instruction and assessment meet the criteria laid out by this checklist item, and an example app will next be discussed.

The experts identified the World History Games (Pearson Education, 2011) app as being designed to teach and assess student learning of subject specific knowledge. This app does not use direct instruction or a quiz tool to assess student knowledge. Instead, students pick a topic, and the app presents them a puzzle that they are to solve related to the topic in two minutes or less, as shown in Figure 1.

Figure 1. World History Games app.

By solving the puzzle, students earn a score and advance in the category. They can also increase their score by solving the puzzle as fast as possible. After solving a puzzle, the app then presents students with additional information about the puzzle's topic before they select the next puzzle. These traits were recognized by the experts and teacher educators for meeting this checklist's criteria because the text it presents is in the form of an interactive puzzle, which provides "a more interesting and challenging learning environment for acquiring knowledge" (Chen & Hwang, 2014, p. 125). The game-based platform of this app engages students in its texts because they are trying to solve the puzzle to earn points. In this way, the app has implications for teaching and assessing student learning of subject specific knowledge.

Checklist Item #2: Does the App use Text that is Appropriate for a Specific Course and/or Group of Students?

An app being used to develop students' content-area literacy skills must include text specifically for a grade level or course. Teachers are the ones who must make the professional decision regarding which materials should be used in the classroom, and this decision-making responsibility has implications for differentiating instruction (West, Hopper, & Hamil, 2010). When differentiating instruction for diverse learners (e.g., English language learners, talented and gifted students, students with special needs, and more); the instructional methods teachers use in the classroom along with the materials they use must be considered (Baecher, Artigilere,

Patterson, & Spatzer, 2012; Puckett, 2011). If students need support, apps that package different types of texts – such as images, audio tracks, and videos – together have the potential to better support student learning because they combine text in a manner that makes the central message being communicated more accessible. It is then the teacher who ultimately makes the decision if that content is packaged in a way that is appropriate for their specific course and students. In this study, the experts and teacher educators identified multiple apps as containing these attributes, of which one will next be discussed.

The Bozeman Science (Anderson, 2015) app, is a database of videos created by Paul Anderson, a classroom science teacher that includes multiple scientific topics and subject areas. When students open the app, they navigate a series of screens to identify the topic of interest. To do so, students first have to select their overarching subject area within science (e.g., Anatomy & Physiology, Biology, Earth Science, etc.). Students are then presented a series of videos organized by topic for that subject area. For instance, in the "Anatomy and Physiology" section, the range of topics students can select is comprehensive and examples include: The Respiratory System, Interstitial Fluid, Thermoregulation, and the Immune System, among several others. When students identify a topic of interest, they can tap it to access its video, and the video created for "The Digestive System" topic is shown in Figure 2.

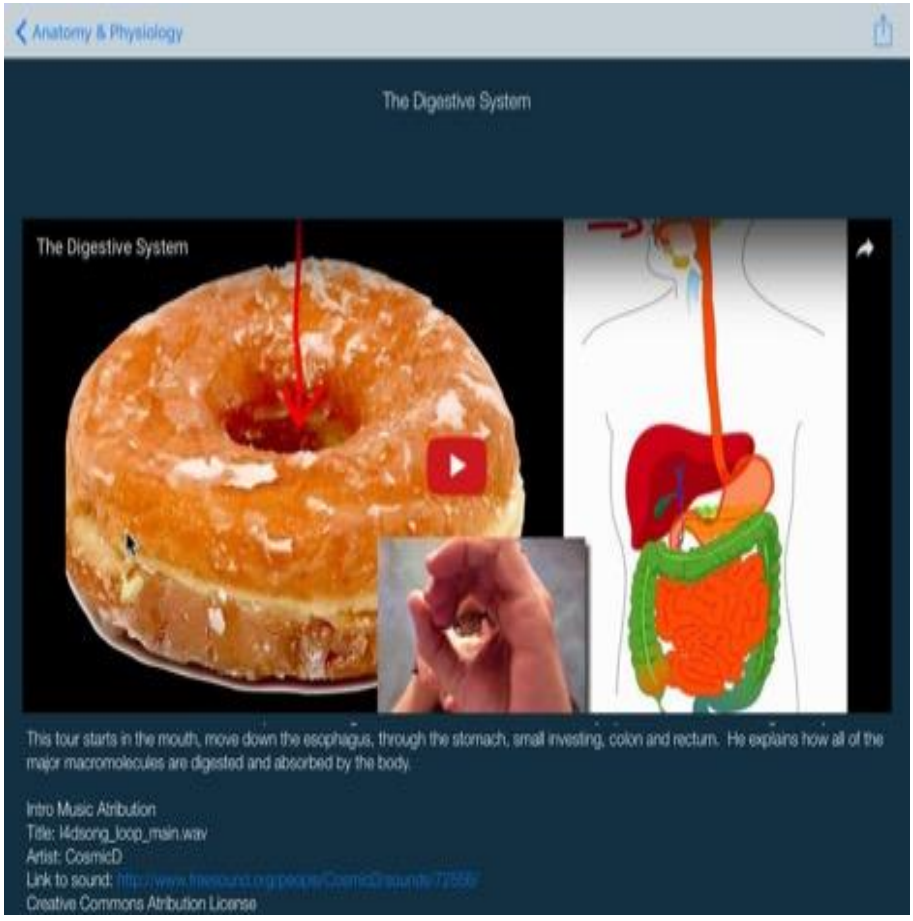

Figure 2. The Digestive System video.

When students tap the screen, the app plays the video. In the video, the narrator uses images, oral language, and written text to communicate information to students, and the app has implications for differentiating instruction for students. When viewing the video, the narrator presents the information in multiple ways, and students are able to fast forward and rewind the video as needed. As a result, this app meets the attributes described in this checklist item because it aligns to several courses within the field of science (and multiple topics within those courses), while using a variety of lettered texts, images, and videos to communicate information to students.

Checklist Item #3: Do the Texts Presented in the App Take the Form of Lettered and Non-Lettered Texts (e.g., Graphs, Images, Numbers, etc.)?

When considering *texts* in this context, the term is not limited to traditionally lettered texts (e.g., Mallin, et al., 2014). Rather, when used in apps, texts become multimodal in that they "combine various media (such as the book, radio, television, and computer screen)… [and] a variety of modes (such as image, animation, and sound) disseminated through a single medium (such as a computer screen)" (Lauer, 2009, p. 229). For example, when using an app for biology, the texts may take the form of articles, charts, figures, and videos. Each of these types of texts provides students with information that is specific to a content area; yet, not in the form of a traditional textbook. In fact, the popular Khan Academy (Khan Academy, 2016) app combines the audio and visual elements so effectively that Forbes Magazine referred to its founder, Salman Khan as "The World's Best Known Teacher" in only eight years (Meyer, 2014). Though the texts can be multimodal, they still must be focused on a specific subject area (e.g., biology, literature, or geometry) according to Conley (2008) and Readance, Bean, and Baldwin (2004). Furthermore, as Langer (1990) explained, the act of reading is an act of interpretation. As applied to this study, texts can then take many forms inside of an app as long as the text can be "read" or interpreted for meaning. In this study, the experts and teacher educators identified the Science Glossary app (Visionlearning, 2012) as having the attributes needed to satisfy this checklist item.

The Science Glossary app (Visionlearning, 2012) provides a comprehensive list of terms used in chemistry, geology, biology, and physics listed alphabetically, which can be searched. Students are able to browse the terms on the left side of the screen and, when they come to a term of interest, can tap it to access its definition. The definition includes hyperlinks to other terms and modules that students can tap, as shown in Figure 3.

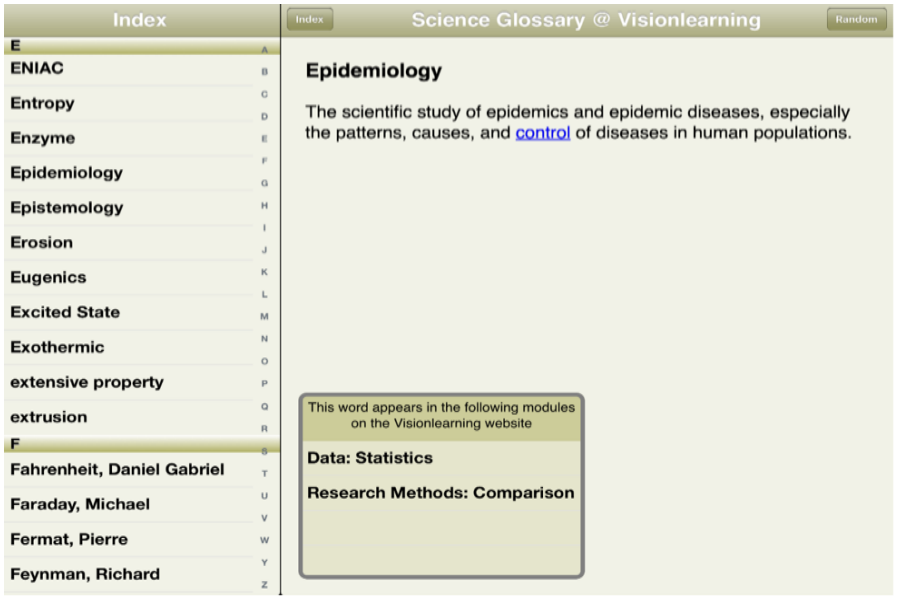

Figure 3. The Science Glossary app.

In this example, students are engaging content-area literacy because the app is focused on a specific subject area and the definitions include hyperlinks that connect to different terms and modules, which make them non-linear texts. Much like a traditional glossary, students can look up the meaning of different words but unlike a traditional glossary, students are able to use the hyperlinks to instantaneously jump from one term to the next, which is a unique feature of how this app uses content-area texts attributes that are non-linear.

Checklist #4: Can General Comprehension Strategies be used to Read, Engage, and Understand the Text?

In the upper elementary and middle grades, content-area literacy has evolved to mean that students learn information through reading and writing (Shanahan, T. & Shanahan, 2012). Furthermore, with the rise of digital technologies in the classroom, "experts have broadened that definition to include attention to technology and other text types" (Moss, 2005, p. 47). In order to engage these content-area texts for learning, Shanahan, T. and Shanahan (2008) explain students must develop their "cognitive endurance to maintain attention to more extended discourse, to monitor their own comprehension, and to use various fix-up procedures if comprehension is not occurring (e.g., rereading, requesting help, looking words up in the dictionary)" (pp. 44-45). In addition to these content-area reading strategies, other researchers have identified the Role, Audience, Format, and Topic (R.A.F.T.) strategy as a technique for students to compose content-area texts (Brozo, Moorman, Meyer, & Stewart, 2013). Both the reading and writing strategies used to develop students' content-area literacy are generalizable so they can be applied across the upper elementary and middle school subject areas. For example, students in all subject areas can use a dictionary to define a word and students can check for their understanding of a text they are reading by asking themselves questions. Furthermore, teachers in all subject areas can use the R.A.F.T. strategy to create writing prompts and assignments that focus on specific topics (Quinn & Thomas, 2013). These assignments require students to plan, draft, and edit their responses,

which are skills that are general to all content areas. With these attributes in mind, the experts and teacher educators identified the iGE Lite (UCL Business PLC, 2013) app as embodying this attribute.

The iGE Lite app (UCL Business PLC, 2013) focuses on teaching grammar rules and usage to students by providing them information about selected topics complete with assessments. When students engage this app, it first allows them to select a topic and then provides them with detailed information about it, as shown in Figure 4.

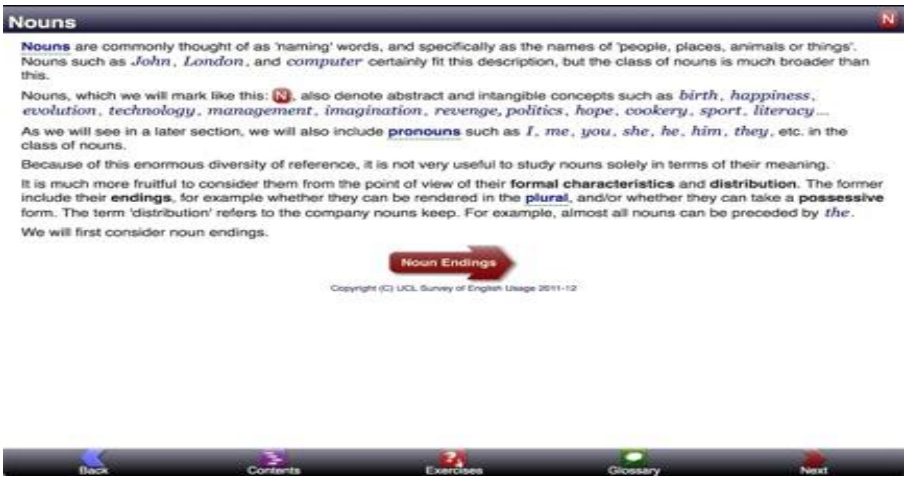

Figure 4. The iGE Lite app.

Students are to read the information to learn about the topic. As they read, the text's length requires both a sustained mental effort for students to learn the content by reading the text and to ensure their comprehension of it by using self-monitoring reading strategies. Once students have read the text and feel confident in their understanding of it, they can choose the "Exercises" feature, which allows them to complete an assessment related to the topic, as shown in Figure 5.

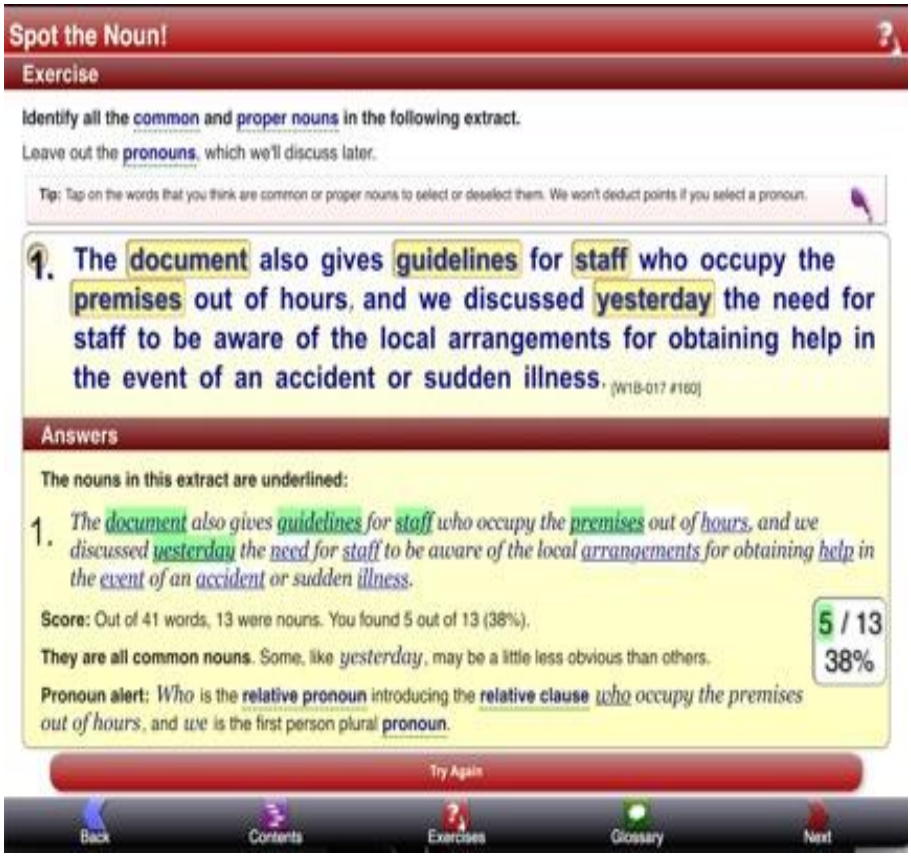

Figure 5. The "exercises" feature.

For each exercise, students are presented a question and are then required to follow the directions in response. In this way, the app evaluates student learning of the topic, which is based off their reading of content-area text supplied in the app. This app provides students with the correct answer, their scores, and additional information about the question. As related to the checklist's fourth item, students can apply a variety of general strategies to comprehend the text in this app and those same strategies can be used across content areas. For example, students can reread the text, look up unfamiliar words in a dictionary, or use context clues to help them understand the text. Furthermore, like text-based activities in all content areas, this app uses a formative assessment to ensure students comprehend or "learn" the information presented in the app.

Implications for the Classroom

This checklist is intended to be a resource for teachers to consult when selecting apps that have characteristics that may develop students' content-area literacy skills. In no way does this checklist substitute for teachers' professional knowledge; the context of their classroom, students, school culture, and instructional technology policies, which must also inform educators' selection of apps. With that backdrop in place, the following recommendations are intended to support teachers' use of the checklist.

First, it is essential teachers have a deep understanding of the app they select. Before applying this checklist to analyze an app, teachers must spend time working with the app, exploring its functionalities, investigating its content, and navigating its different screens, settings, and options. Once they have a strong working knowledge of the app's content and design, they can then apply the checklist to analyze its attributes for developing students' content-area literacy skills using it. For example, when using the Science Glossary app, teachers need to be aware of how the app lists the different terms and that the app links different terms in its glossary to each other. The end result is that the terms form a web, where one term then needs to be comprehended in order to understand an additional term. Only by exploring the app deeply and understanding nuances such as the interconnection of terms can teachers truly use the checklist to analyze its attributes for content-area literacy.

Second, even if an app possesses the attributes identified for content-area literacy, teachers are still the ones who must create the learning activities. Koehler and Mishra (2009) introduced the Technological, Pedagogical, and Content Knowledge framework (TPACK). In this framework, teachers are responsible for blending their subject area's content knowledge with teaching strategies that infuse instructional technologies to promote student learning. When teachers use this checklist and identify that an app has the attributes for developing students' content-area literacy skills, they cannot simply just have the students "use" the app. Rather, they need to embed that app into a lesson, so that it enables students to deeply study a subject-specific content for a specific purpose. For instance, when viewing a video hosted on the Bozeman Science app, teachers still need to set a purpose for viewing the video and also create an activity or assessment directly related to the video, such as presenting the key information gained from the video, applying the knowledge from the video to an experiment, or completing a graphic organizer based on the video's content. In these ways, the app is not a standalone piece of instruction, which may qualify it as being used as technology for technology's sake. Rather, by blending the app into a well-designed lesson, the app would enhance student's content-area literacy and the knowledge gained from the app would be applied to other parts of the lesson.

Third, the checklist should not be seen by teachers as an evaluation tool for an app's overall worth. Multiple rubrics have been created to analyze the value of apps (Buckler, 2012; Cherner et al., 2016; Lee & Cherner, 2015, Walker, 2011), and teachers should not view this checklist as a rubric. Rather, the checklist should be seen as a guide for considering how an app may be used as an instructional tool for developing students' content-area literacy skills. For instance, if an app includes only certain characteristics for content-area literacy instruction, teachers need to ensure their instruction maximizes that app's attributes while using other materials and resources to compensate for its shortcomings. For example, if an app meets all the criteria in the checklist but only includes one type of text, such as only lettered text, teachers may still be wise to use that app; however, they would need to bring in additional images, charts, and videos related to the topic. By doing so, students could read the lettered text provided by the app and then refer to the additional texts offered by the teacher to further their understanding of the topic being studied.

Finally, teachers can use this checklist to help them differentiate their instruction for students and provide additional resources for students. The checklist's second item is geared to analyze the appropriateness of text for specific students. Teachers need to be cognizant that though a text may be appropriate for one group of students, it might be inappropriate to use with another group. When selecting an app to use in a class, some students in the class might be gifted and talented while other groups of students might be English language learners or need extra

support. If that is the case, teachers will need to consider the group of students they are selecting the app for and they may likely need to select multiple apps to use when working with a diverse group of students. With these implications in mind, it is essential that teachers see themselves as the professionals in the classroom and as being empowered to make the best decision regarding which apps to use (See the Appendix for further information about apps).

Conclusion

The amount of instructional technology is continually growing, and teachers are using them at increasing rates with their students. At the same time, developing students' content-area literacy skills has become a national educational initiative with the adoption and implementation of a new generation of standards. As a result, the methods and materials used to develop students' reading and writing skills needed to learn and demonstrate subject-specific knowledge has changed dramatically. Plus, with all these changes happening in a relatively short time span, teachers now more than potentially ever need quality, research-supported resources at their disposal when selecting apps to be used in their classroom. In response, the purpose of this study was to create, test, and explain a checklist that teachers could use to identify apps for developing students' content-area literacy abilities. It was the dual intent of the authors to provide such a tool while also modeling how to bridge the research-to-practice gap. It is also hoped that this work provides both a useful tool to teachers and an example for using research to provide practical tools for improving instructional practice in the classroom.

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Appendix

More to Explore

Websites for App Information:

- For information about how to install and manage apps on an iPad: https://www.gcflearnfree.org/ipadbasics/installing-and-managing-apps/1/
- For information on how to find a great educational app: https://www.newamerica.org/education-policy/edcentral/find-ed-apps/
- Resources for iPad apps on literacy instruction, from the International Dyslexia Association: https://dyslexiaida.org/ipad-apps-for-literacy-instruction/
- Resources for using iPads in grades 6-8, from Edutopia: https://www.edutopia.org/ipad-apps-middle-school-resources
- Resources for using iPads in grades 9-12, from Edutopia: https://www.edutopia.org/ipad-apps-high-school-resources