Why this App? How Educators and Parents Choose Good Educational Apps

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Dedication

To Shaahin, my amazing husband for all his love, patience and continuous care.

With you everything is possible!

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To Mom and Dad for their endless love, affection, encouragement, and support.

Acknowledgments

I would like to show my sincere gratitude to my supervisor, Dr. Adam K. Dubé, for his guidance, patience and endless support in supervising this thesis. Without him and his insightful suggestions this thesis would have never been accomplished. A special thanks to my dear friend and research partner Heather A. Pearson for her assistance during this study. I would also like to thank the dear members of Technology, Learning, and Cognition Lab (TLC) for their continuous support and encouragement. Above all, my thanks go to everyone who participated in the study. This thesis would not be completed without their valuable input.

Abstract

Over 80% of top selling educational apps are targeted at children. Thus, it is critical to know how educators and parents are choosing apps for students. It is also paramount to understand what indicates a quality educational app that enhances learning. Through the use of two theoretical frameworks (i.e., TPACK and U&G), educators and parents app selection behavior were investigated. Educator and parent app selection will provide insights into their TPACK and app specific needs, respectively. The present studies investigated which features educators and parents value when selecting apps from the App Store. This question was addressed by two studies, an eye tracking study with educators (n = 57) and an online study with parents (n = 180). In both studies, participants viewed 10 mock math apps that replicated the App Store presentation format. Five apps included key educational benchmarks and five contained educational buzzwords. Immediately following each app, participants provided value judgements of the app (e.g., would you download it?). Results indicated that both educators and parents value educational benchmarks over buzzwords; both value apps that feature development team, scaffolding, and guiding curriculums more than those with central learning theories and feedback. Thus, educators' educational app knowledge and parents' app needs seem to align with some, but not all, of the research on what makes a good educational app.

Keywords: educational apps, app selection, educational benchmarks, TPACK, U&G theory

Abrégé

Plus de 80% des applications éducatives les plus vendues sont destinées aux enfants. Il est donc essentiel de savoir comment les éducateurs ainsi que les parents choisissent les applications pour les élèves. Il est également primordial de comprendre ce qui indique une application éducative de qualité qui améliore l'apprentissage. Grâce à l'utilisation de deux cadres théoriques (e.x. TPACK et U&G), la façon dont les parents et les enseignants sélectionnent l'application a été étudiée. Le choix des applications pour les enseignants et les parents fournira des informations sur leurs besoins spécifiques en matière de TPACK et d'application, respectivement. Ces études concernées ont examiné les caractéristiques des éducateurs et des parents lors de la sélection des applications dans l'App Store. Cette question a été abordée par deux études, une étude de suivi oculaire avec les éducateurs (n = 57) et une étude en ligne avec les parents (n = 180). Dans les deux cas étudiés, les participants ont observé dix applications mathématiques simulées qui répliquaient le format de présentation de l'App Store. Cinq applications comprenaient des repères éducatifs clés et cinq contenaient des mots à la mode éducative. Toute suite après suivi de chaque application, les participants ont fourni des jugements de valeur concernant l’application concernée (e.x., la téléchargeriez-vous?). Les résultats ont indiqué que les éducateurs et les parents accordent plus d'importance aux repères pédagogiques qu'aux mots à la mode; les deux catégories apprécient plus les applications qui comprennent une équipe de développement, un échafaudage et des programmes d'orientation par rapport aux celles avec des théories d'apprentissage centrales et des commentaires. En conséquence, la connaissance des enseignants des applications éducatives et aussi les applications exigées par des parents semblent correspondre à certaines mais pas à toutes les recherches sur ce qui fait une bonne application éducative.

Mots clés: applications éducatives, choix d’application, repères pédagogiques, TPACK, Théorie U&G

Why this App? How Educators and Parents Choose Good Educational Apps.

In developed nations like Canada, tablets and smartphones are available in almost every household (i.e., 76% smart phone, 54% tablet or e-reader, Statistics Canada, 2017), along with a high rate of internet access (i.e., 91% of Canadians use the internet, Statistics Canada, 2019). As a result, individuals have fast and easy access to numerous resources, tools, and learning platforms that allows educators, parents, and students to augment their pedagogical experiences (Fabian et al., 2016). In fact, technology is capable of transforming and improving the teaching and learning experience on many levels (Falloon, 2017; Goodwin, 2012). For instance, implementing new and innovative digital tools, decreasing the cognitive load on learners, easier visualisation of scientific concepts, easier research, faster flow of information, accessibility of countless resources, sharing findings, as well as communicating concepts and content (Camilleri & Camilleri, 2017; Falloon, 2017; Warren et al., 2008; Zydney & Warner, 2016). Technology's effect on teaching and learning has also modified the way in which instruction is delivered (Shute & Ke, 2012).

Society is looking to mobile technologies (i.e., tablet technologies) and touch devices as educational tools (Falloon, 2017; Goodwin, 2012; Olney et al., 2008). Considering that the educational system and society are investing in mobile technologies (Cherner et al., 2014; Ludwig & Mayrberger, 2012), educators are being encouraged to provide this technology in their classrooms and develop young learner's digital literacy for these tools (Cherner et al., 2014; Pearsall, 2014). This being so, educators need to adapt their teaching designs and methodologies and ensure they still meet students' needs and learning approaches (Camilleri & Camilleri, 2017; McLoughlin & Lee, 2010). Similarly, thanks to modern technologies, there are many digital learning tools for parents to choose from. Again, mobile technologies are key players in children's learning beyond a classroom setting (Chee et al., 2017; Shuler et al., 2012). Despite concern about the potential risk or benefits of these devices (Ebbeck et al., 2016), there has been a significant growth in the ownership and use of mobile devices among young children (Common Sense Media, 2013; Glaubke, 2007; Radesky et al., 2015). As a result, parents are rapidly adapting to the role of touch screen devices in their young children's lives (Lovato & Waxman, 2016). Some parents consider them as educational tools (Goodwin & Highfield, 2012) and download content (i.e., applications) for their children to use (Shuler et al., 2012). For example, a recent study found that just over half of parents in Canada and China report downloading mathematics application for their children (Alam et al., 2020). Critically, it is argued that touch screen devices can improve learning outcomes for children (Dubé et al., 2019) if the correct educational application is used (Camilleri & Camilleri, 2019; Cohen et al., 2011).

Educational Applications

As reported by Apple in 2018, there were 200,000 educational and reference apps available in the App Store (Cnet, 2018). In comparison to 2015's 80,000 educational apps (Hirsh-Pasek et al., 2015), this represents an approximate 125% growth over a three-year period. Furthermore, according to an early study of educational apps in the App Store, over 80% of top selling educational apps are targeted at children (Shuler et al., 2012). Therefore, mobile applications can be considered a dominant medium for providing educational content to children. From recent studies of educational apps, there is mounting evidence that children can learn from well-designed educational apps (Cayton-Hodges et al., 2015; Chiong & Shuler, 2010; Dubé et al., 2019; Falloon, 2013; Hirsh-Pasek et al., 2015). A brief review of these studies will demonstrate how quality apps can contribute to better learning outcomes.

As stated by Dubé et al. (2019), well-designed apps provide children with the opportunity to experience multi-level engagement that includes behavioral, affective, and cognitive components which can lead to increased interest or competence in the subject being taught (e.g., math). Multiple studies suggest that educational apps contribute to children's cognitive development by providing the context to employ and enhance cognitive skills (Blumberg & Fisch, 2013; Camilleri & Camilleri, 2019; Dubé et al., 2019; Falloon, 2013; Hirsh-Pasek et al., 2015). Furthermore, research suggests that well-designed educational apps lead to learning through many different avenues. For example, interactions (e.g., gestures) that cause learners to physically engage with the app content can produce cognitive engagement via embodied cognition (Dubé & McEwen, 2015; Dubé et al., 2019). Similarly, virtual manipulatives found in many educational apps can improve understanding of abstract concepts (Moyer-Packenham et al., 2015). While educational apps are mostly argued to improve learning outcomes, research suggest they are also able to increase motivation (Burguillo, 2010; Hirsh-Pasek et al., 2015) and improve attitudes towards learning if they provide a sense of control and value (Dubé et al., 2019). Well-designed apps provide children with an appropriate level of control and agency, in line with their age and experience, that allows them to progress at their own pace and sustain interest in learning (Hirsh-Pasek et al., 2015). Cohen et al. (2011) even argue that using a well-designed app can help progress children quickly from novice to mastery. Above all, educational apps provide access to teaching and learning resources (Camilleri & Camilleri, 2017; Papadakis & Kalogiannakis, 2017) and this is argued to make them an accessible learning tool, capable of bridging the gap between school learning and home learning (Shuler et al., 2012).

It can be concluded that well-designed apps have the potential to positively impact learning outcomes. Given the increasing number of educational apps being produced (Hiniker et al., 2015; Papadakis & Kalogiannakis, 2017), it can be challenging to find the ‘well-designed’ apps among the many that are available (Ok et al., 2016). In fact, the process of finding the right educational app is a matter of concern and interest for researchers, educators, and parents. It is therefore crucial to investigate and identify indicators or benchmarks of quality that can be used to spot well-designed educational apps in app stores.

The Apple App Store

The App Store was first opened on 2008, with an initial 500 applications (Apple, 2020). As of the first quarter of 2020, the App Store featured almost 1.85 million apps for iOS (Statista, 2020) from which over 200,000 are educational and reference apps (Cnet, 2018). It is in fact one of the principal platforms where developers or companies exhibit their apps to potential customers, and users can browse and download apps according to their needs and purposes. Thus, an understanding of how educational apps are found and presented in the Apple App store is critical for studying how educators and parents select well-designed educational apps.

The Apple App Store search system. When searching on the App Store for “education” apps, educators and parents can narrow down their search and browse according to different categories and criteria (Cherner et al., 2014; Dubé et al., 2020). Using the filters menu (see Figure 1), they can search based on the type of device supported (iPad only, Phone only, both), price (free or paid), subject area (i.e., educational vs other), and age groups as well as different criteria such as relevance, popularity or rating. However, the quality of this search system has been a matter of concern (Cherner et al., 2014; Dubé et al., 2020; Larkin, 2013).

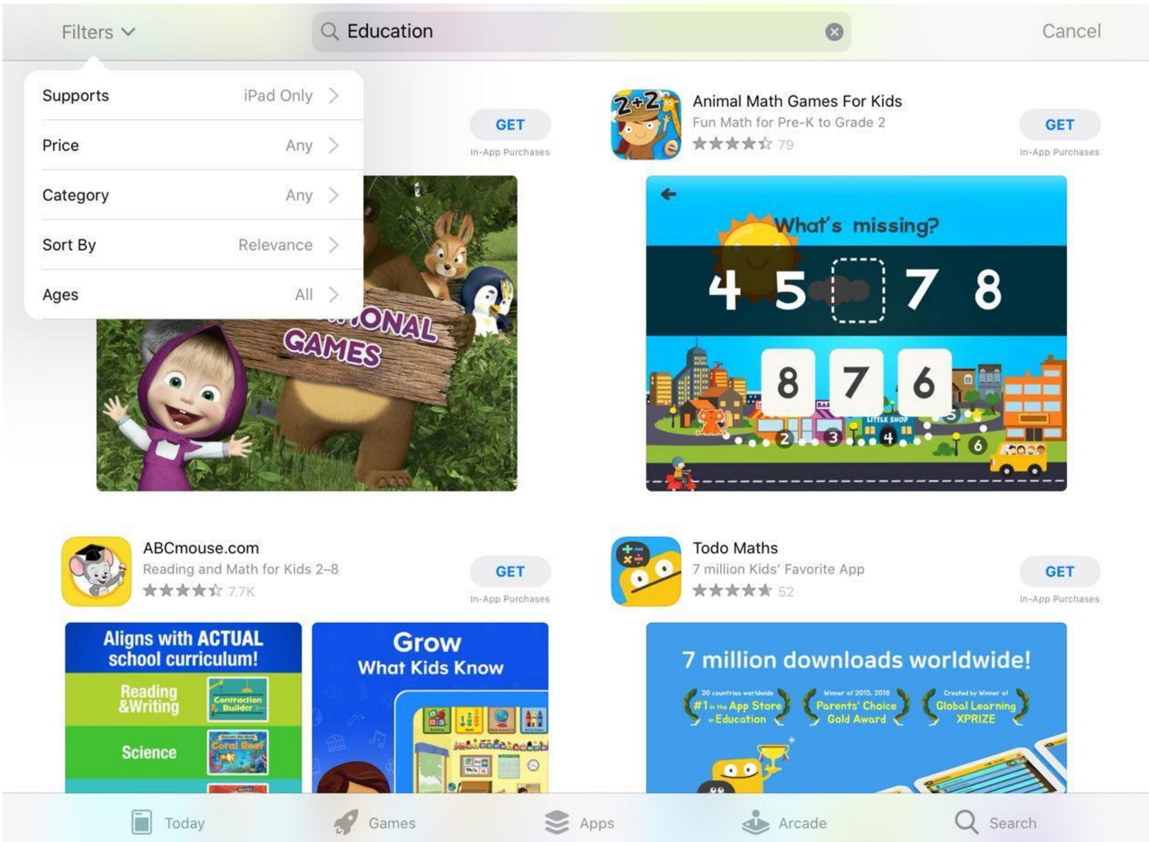

Figure 1. Screenshot of the App Store, July 1st, 2020

Issues with Apple App Store search system. The high number of educational apps has made it challenging for educators and parents to select the most suitable apps to support students' learning (Bano et al., 2017; Cherner et al., 2014; Larkin, 2013). Moreover, due to the lack of organization on the App Store, educators and parents may simply become overwhelmed and disregard quality apps (Cherner et al., 2014; Larkin, 2013). This lack of organisation ranges from classifying apps with no discernible pattern (e.g., app function, purpose, subject area), to assigning subject headings that do not match the app content (Cherner et al., 2014). Further, the absence of a published official Apple app rating system (Papadakis & Kalogiannakis, 2017) has raised concerns about the lack of transparency with how apps are rated in the App Store itself (Dubé et al., 2020). For example, a study by Dubé et al. (2020) reveals that only 55% of apps in their study had a rating. In addition, Vaala et al. (2015) points out that majority of apps that are expert-awarded (e.g., Common Sense education’s top apps) are not in the App Store’s “Top educational apps” category. Furthermore, Apple assigns a ‘rank’ to apps that should convey its standing relative to other similar apps (Dubé et al., 2020), but not all apps have a rank assigned to them, it is unclear how an app’s ranking is calculated, and what the app ranking exactly means is unknown (e.g., an app can be ranked #75 but with no information on how many apps are in the category, 100, 1000). A study on the best-selling apps in four European countries pointed out similar issues with the Apple ranking system. For instance, it is not defined how many user downloads are behind the app rankings or which underlying parameters are considered in assigning a rank to an app (Sari et al., 2015). Therefore, being at the top of the App Store’s rating or ranking result does not indicate the educational quality of an app (Dubé et al., 2020). All these issues make the app selection process more challenging, complicated, and time consuming for educators and parents (Cherner et al., 2014; Dubé et al., 2020).

Issues with App Store’s “education” category. Special emphasis is placed on removing the barriers that stand in the way of finding quality educational apps (Cherner et al., 2014; Dubé et al., 2020; Papadakis & Kalogiannakis, 2017). One of the major barriers is the App Store’s policy towards the apps in the education category. The App Store’s education category includes some apps that clearly do not belong (Kolâs et al., 2016). In fact, multiple studies have concluded that there is seemingly no regulatory oversight or review regarding the educational potential of the apps available in the App store (Goodwin, 2012; Hirsh-Pasek et al., 2015; Vaala et al., 2015).

Due to the lack of an industry standard indicating the criteria of an educational app (Shuler, 2012; Papadakis & Kalogiannakis, 2017), the App Store has been filled by apps that are labeled as educational without being tested or verified as such (Levine, 2012; Hirsh-Pasek et al., 2015; Zosh et al., 2016; Vaala et al., 2015). In fact, there are apps that claim to be educational or educationally beneficial just based on inclusion of some educationally related content (Shuler, 2009; Hirsch-Pasek et al., 2015). Consequently, with no standard of quality, educators and parents are left with no choice but to purchase and examine the apps themselves (Cherner et al., 2014; Dubé et al., 2020; Falloon, 2017). Some even make the mistake of selecting apps randomly from the education category and using them without testing their educational quality and end up with educationally useless apps (Ok et al., 2016). Shuler (2009) suggested parents' magazines and websites (e.g., Common Sense Media, Consumer Reports, and Parent's Choice) provide consumer information and guidance to assist the app selection process. Given the vast number of educational apps in the App Store, standards of quality or specific criteria for the education category are needed to facilitate the app selection process (Vaala et al., 2015). Once a specific app is found, there are issues with how the app is presented in the store.

Presentation of Apps in the Apple App Store. In the App Store, different features of the apps are presented in the forms of visual and textual information (i.e., images and text descriptions) in the app page (see Figure 2). Visual information includes the app icon and images of the app while textual information includes the written description and other information such as price and file size. While choosing apps, users are influenced by not only their personal or educational goals and interests but also the visual and textual information of the apps (Dubé et al, 2020). These images and text descriptions can contain critical information that enable customers (e.g., educators, parents) to make informed decisions whether to download an app or not (Vaala et al., 2015). The content found in an app's page is the only information developers provide about their app to customers (Lee & Raghu, 2014). Therefore, it is crucial to know if it contains helpful information (i.e., indicators of educational quality) and to know how educators and parents select apps based on them.

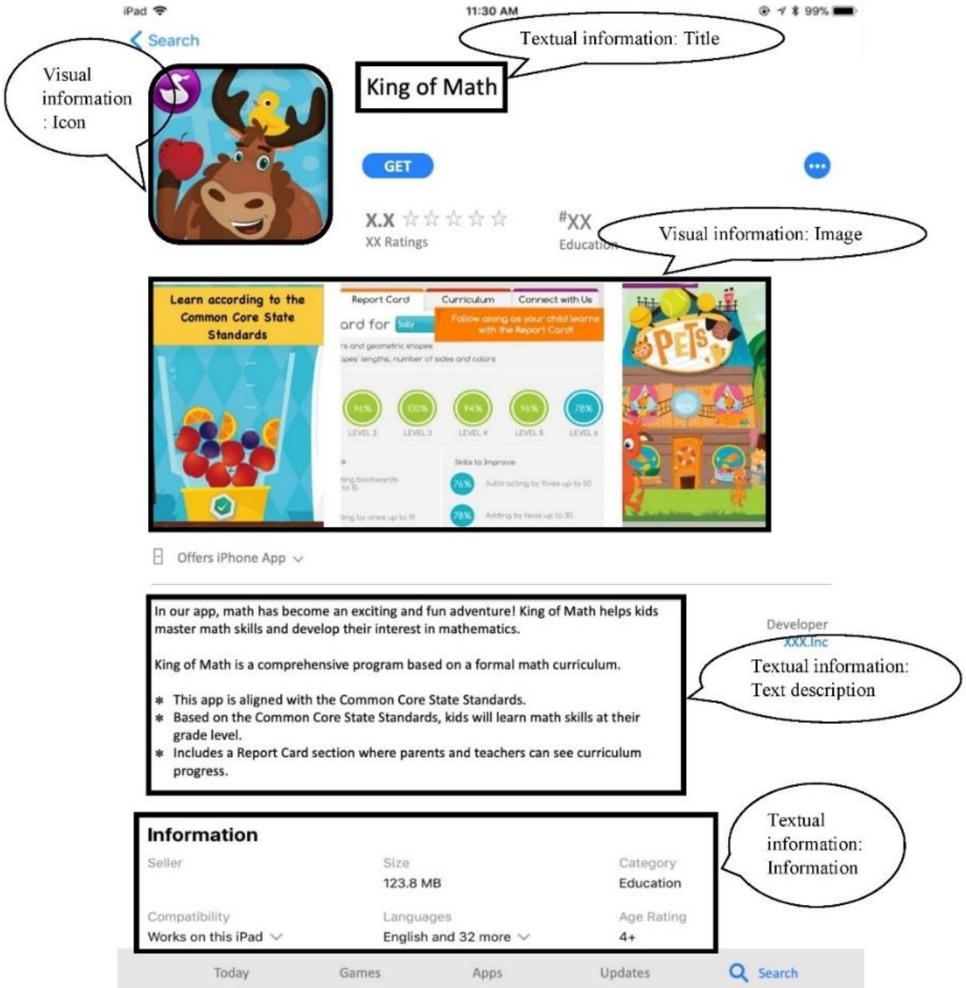

Figure 2. Presentation of an app in the App Store

Issues with app descriptions. The App Store does not provide enough quality information (e.g., indicators of educational quality) to assist the app selection process (Dubé et al., 2020; Larkin, 2013; Vaala et al., 2015). According to Vaala et al. (2015), there is a remarkable variation in the amount of information provided for each app. Even when sufficient information is provided, inconsistencies between app descriptions and actual app content is also a matter of concern (Larkin, 2013). Regardless of the amount of information provided, lack of essential information in text and image descriptions is one of the major challenges faced by educators and parents trying to find appropriate apps (Dubé et al., 2020; Vaala et al., 2015).

Theoretical Frameworks

As discussed earlier, the App Store does not provide adequate information to users (i.e., educators, parents) to make informed decisions while choosing educational apps (Dubé et al., 2020; Larkin, 2013; Vaala et al., 2015). Moreover, educators and parents often express challenges in finding effective apps due to lack of guidance for figuring out what makes a good educational app (Dubé et al., 2019; Ok et al., 2016). Also, the critical matter of how educators and parents are managing to choose quality apps among all existing apps from the App Store has not yet been explored and understood (Dubé et al., 2020). It is therefore crucial to conduct research on how educators and parents are actually choosing educational apps. Reviewing different studies led to the identification of two theoretical frameworks which help to better understand their app selection process.

Educators' App Selection Process

Selecting appropriate apps is of great importance, as well-designed apps are capable of supporting and enhancing children's learning process (Bennett, 2011). Educators are the individuals who play the key role in integrating the technology into the classroom, as well as evaluating and selecting educational apps for students (Cherner et al., 2014). Therefore, it is extremely important to look at this process from their perspective and investigate educators' knowledge, perceptions, and beliefs regarding their selection and utilisation of digital learning technologies. The Technological, Pedagogical, and Content Knowledge (TPACK) framework has been used by different researchers to investigate educators' attitudes towards the use and integration of educational technologies (e.g., educational apps) (Mishra & Koehler, 2006). Thus, it follows to understanding teachers' selection of educational apps using TPACK.

TPACK framework. The Technological Pedagogical Content Knowledge (TPACK) framework was first designed by Mishra and Koehler (2006) to understand the knowledge educators require to effectively integrate technology into their teaching process. The TPACK framework was based on the notion of "knowledge in teaching" by Shulman (1986). According to Shulman (1986), educators have content knowledge (i.e., knowledge of the subject they are teaching) and pedagogical knowledge (i.e., knowledge of how to teach). The TPACK framework was developed by adding technology to Shulman's pedagogical content knowledge (PCK) framework. TPACK focuses on how educators need to connect and interact all three knowledge areas (i.e., technology knowledge (TK), pedagogical knowledge (PK), and content knowledge (CK)) to successfully integrate technology into the learning process and classroom setting (Mishra & Koehler, 2006).

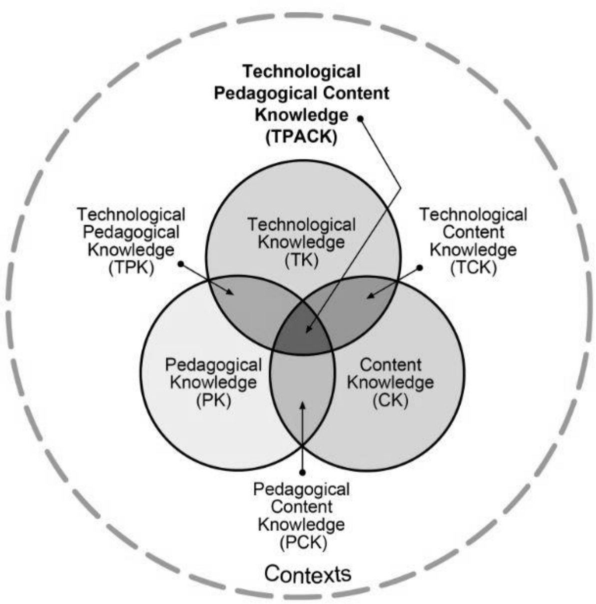

Figure 3. The seven components of TPACK. is adopted from http://tpack.org "Reproduced by permission of the publisher, © 2012 by tpack.org"

As defined by Koehler and Mishra (2006; 2009), the TPACK framework consists of seven components (see Figure 3). Including the three forms of knowledge as well as the intersections between these three primary forms (Koehler, 2012). Content knowledge (CK) is the educators' knowledge about the subject matter (i.e., materials, concepts, and theories) to be learned or taught (Koehler & Mishra, 2009; Shulman, 1987). Pedagogical knowledge (PK) is knowledge about the processes and methods of teaching and learning of a subject matter (i.e., instructional methods and discipline-specific methods) (Cherner et al., 2014; Koehler & Mishra, 2009; Shulman, 1987). Technology knowledge (TK) is knowledge about the use of different technologies (i.e., technology tools and resources) to support and deliver their instruction (Cherner et al., 2014; Koehler & Mishra, 2009). TK is a fulsome understanding of technology which enables the educators to decide whether the technology can assist or hinder the achievement of a learning goal (Koehler & Mishra, 2009). Pedagogical content knowledge (PCK) is specific knowledge of teaching process that focuses on the transformation of the subject matter according to educators' pedagogical interpretations and adaptations (Shulman, 1986). PCK is required for effective teaching as it helps to tailor, adapt, alternate, and simplify a subject with respect to students' capabilities and prior knowledge (Koehler & Mishra, 2009; Shulman, 1986). "PCK covers the core business of teaching, learning, curriculum, assessment and reporting, such as the conditions that promote learning and the links among curriculum, assessment, and pedagogy" (Koehler & Mishra, 2009, p. 64). Technological content knowledge (TCK) is the knowledge of how technology and content have an effect on one another and how applying particular technology can construct new kinds of representations of a specific subject matter (Koehler & Mishra, 2009). As pointed out by Koehler and Mishra (2009), it is required for educators to acquire the knowledge of which specific technology best address their needs while dealing with a certain subject matter in their domains. Technological pedagogical knowledge (TPK) is the knowledge of how using particular technologies in particular ways can change the process of teaching and learning (Koehler & Mishra, 2009). TPK highlights how technology and pedagogy influence one and other and how using technology may affect the way a material is taught by educators (Koehler & Mishra, 2009). Finally, the seventh component is technological pedagogical content knowledge (TPACK). TPACK emphasizes the interrelationships between educators' technology use, instructional methods, and understanding of the subject matter (Bas & Senturk, 2018; Mishra & Koehler, 2006). Possessing all three sets of knowledge is central to have effective teaching with technology. As stated by Koehler and Mishra (2009):

> TPACK is the basis of effective teaching with technology, requiring an understanding of the representation of concepts using technologies; pedagogical techniques that use technologies in constructive ways to teach content; knowledge of what makes concepts difficult or easy to learn and how technology can help redress some of the problems that students face; knowledge of students' prior knowledge and theories of epistemology; and knowledge of how technologies can be used to build on existing knowledge to develop new epistemologies or strengthen old ones. (p. 66)

According to Mishra & Koehler (2008), different technologies have their own potentials, features, uses, and constraints that make them more appropriate for certain tasks in comparison to others. Therefore, educators are required to obtain the adequate knowledge on how to successfully integrate different kinds of technology with specific content and pedagogy in order to have an effective learning environment (Koehler & Mishra, 2009).

TPACK and app selection. The app selection process can be situated in the technological knowledge (TK) component of the TPACK framework. Since educators utilize educational apps as a technological component in their instruction, an in-depth knowledge of apps, their purposes, their functions, as well as their quality indicators is needed (Cherner et al., 2014). Educators need to make informed decisions while choosing educational apps and it would only be possible if they have a thorough understanding of apps (i.e., knowing how and for what reasons they should integrate specific apps into their teaching process). Otherwise, the process would result in the selection of educational apps that would not fulfill students' instructional needs (Cherner et al., 2014). Therefore, possessing TK is paramount to the app selection process as it supports educators to better match an app with specific content and pedagogy. Within the present study, TPACK is understood to constitute the connections among educators' technological knowledge of educational applications, instructional methods, and subject matter, with their level of technological knowledge (TK) being critical to the act of choosing educational apps from the App Store.

Parents' App Selection Process

As with many other decisions in children's lives, media and app selection and use is largely directed by parents (Broekman et al., 2016; Nikken & Schols, 2015; Rideout & Hamel, 2006). Therefore, the rationale behind the parents' decisions should be investigated to understand what they are mainly influenced by while selecting educational apps for their children. Compared to research conducted on traditional mass media (e.g., radio, TV, newspaper), there are a limited number of studies exploring the role of parents in children's touch screen media selection and use. However, there is a theoretical framework that has been used by different researchers to investigate parents’ selection of mobile technologies for their children called Uses and Gratifications theory (Broekman et al., 2016, 2018; Dunne et al., 2010; Li et al., 2015).

Uses and Gratifications theory (U&G). Uses and Gratifications theory (U&G), has mostly been used in mass communications research (Babrow, 1987; Elliott & Rosenberg, 1987). It was first introduced by Katz et al. (1973) suggesting that people use the media to satisfy their psychological needs and to achieve their personal goals. In contrast with preceding theories that viewed audiences as passive, U&G theory is an audience-oriented approach (Blumler, 1979; Katz et al., 1973; Rossi, 2002; Rubin, 2009) that views the audience (i.e., users) as an active group of people who are consciously selecting their desired media and media content to fulfill and satisfy their personal needs and expectations (Katz et al., 1973; Rossi, 2002; Rubin, 2009). Therefore, U&G theory can be considered as an appropriate approach for exploring the needs and expectations of parents and their decision making while selecting educational apps for their children.

Parents are “gatekeepers” when it comes to determining the type of apps their children use (Broekman et al., 2016; 2018). Therefore, it is vital to identify parents’ most dominant needs while selecting apps for their children. Broekman et al. (2016) identified five general needs that users seek in any type of media, including the need for entertainment, information seeking, social interaction, emotional satisfaction, and passing time. According to Sundar and Limperos (2013) study on gratification and “new media” (e.g., smart phones, smart phones’ apps), there are also new sets of needs and gratifications that emerge with new media, called “medium-specific needs”. Therefore, in addition to the abovementioned “general needs”, there will always be emerging “medium-specific needs”. In terms of apps, Broekman et al. (2016) refers to these needs as “app-specific needs” and argues that app users are not only motivated to use apps to attain their general needs but also to fulfill needs specific to apps (e.g., educational outcomes).

U&G and app selection. As stated by Broekman et al. (2018) “The fundamental assumption underlying U&G is that the consumer (in this case, the parent) selects media (in this case, apps) based on the anticipated gratifications (parental need fulfillment) from the product” (p. 368). It is obvious that every individual seeks gratifications when using media and technology (Dunne et al., 2010; Li et al., 2015). As such, apps aimed for children should address both parents and children’s (i.e., media selector and actual user) expectations. Indeed, parents choosing apps should endeavor to include and fulfill both their own needs (parent-centered) and the perceived needs of their children (child-centered) (Broekman et al., 2016; O’Connor et al., 2014). Evidently, parents consider both parent-centered and child-centered needs in their media selection (O’Connor et al., 2014). However, in some cases parent-centered needs may not fulfill the same goals as child-centered needs (e.g., parents in need of free time choosing apps that merely occupies the child with no educational value). Thus, parent-centered needs are not always beneficial for both parties involved (Broekman et al., 2016).

Selection of the right app is of great importance as it can become a tool to support children’s learning and development. It is crucial yet difficult to understand the motivations of parents while selecting educational apps. Some parents may value the educational aspects of apps when selecting apps for their children, while others may place greater value on the entertainment features of apps (Broekman et al., 2016; 2018). A recent survey conducted by Broekman et al. (2018) reveals the criteria that parents hope to see in their children’s apps (i.e., educational and non-educational apps). They want to find apps with a) clear design, b) tailorable, controllable, educational content, c) challenges and rewards, and d) technological innovation. As parental needs highlight what parents want in apps for their children, studies have provided ideas of the types of features that children's apps could include (Broekman et al., 2016; 2018). Similarly, through the lens of U&G theory, we can investigate parents' app selection process and gain insights into which needs they are fulfilling when selecting educational apps. Thus, U&G theory can help us understand the extent to which research-based educational benchmarks satisfy parental needs for educational apps.

Determining the Quality of Educational Apps

The TK aspect of TPACK and the U&G theory are helpful frameworks for understanding and studying how educators and parents choose quality educational apps. As discussed earlier, determining the educational quality of apps is a problematic task (Yusop & Razak, 2013). Consequently, finding quality educational apps that truly augment the process of teaching and learning can be a daunting and time-consuming chore for educators and parents (Papadakis & Kalogiannakis, 2017). To address this challenge, various evaluation rubrics, codes, or frameworks for assessing educational apps have been proposed to facilitate the app evaluation process (Callaghan & Reich, 2018; Cherner et al., 2014; Falloon, 2013; Handal et al., 2013; Highfield & Goodwin, 2013; Hirsh-Pasek et al., 2015; Martín-Monje et al., 2014; Rosell-Aguilar, 2017; Vaala et al., 2015). However, many of these frameworks are subject-specific and thus not applicable to other subject-based apps (e.g., Martín-Monje et al., 2014 & Rosell-Aguilar, 2017 frameworks for language learning apps) and some emphasize the technical aspects rather than the educational aspects of the apps (e.g., manipulability, Highfield & Goodwin, 2013 and usability, Walker, 2011). Among these studies, some suggest that there are also purely educational features (i.e., educational benchmarks) that can be considered as signifiers of quality educational apps. These educational benchmarks are not subject-specific (e.g., specific to math or literacy); on the contrary, they are transferable and could be applied across different subject areas (Vaala & Levine, 2015). These features can be mentioned in and thus be conveyed through an app's App Store description (e.g., image, text description) and can assist educators and parents in distinguishing quality apps (Callaghan & Reich, 2018; Cayton-Hodges et al., 2015; Dubé et al., 2020; Vaala et al., 2015).

Benchmarks of Quality Educational Apps

There are five educational benchmarks that have been identified as indicators of app quality (Dubé et al., 2020). They include a development team that involves educators, possessing a guiding curriculum (Vaala et al., 2015), being based on a learning theory (Kebritchi & Hirumi, 2008), containing scaffolded learning, and providing feedback (Callaghan & Reich, 2018; Cayton-Hodges et al., 2015). Dubé et al. (2020) suggest that including these meaningful benchmarks in the apps' App Store's text descriptions or images could facilitate educators and parents' app selection and decision-making. The following sections will define each of these educational benchmarks, demonstrate how their inclusion in educational apps enhances learning, and argue that each one constitutes a benchmark of educational quality.

Development team. This feature refers to apps being developed in consultation with an interdisciplinary team of experts (e.g., developmental, educational, and content-specific experts, Vaala et al., 2015). It is crucial that the app development team possess the most recent educational and pedagogical knowledge and that they apply it accordingly while creating apps (Papadakis et al., 2018). In order for learning to take place, app designs should be guided by experts in developmental science to ensure the app is aligned with the learner's developmental needs and abilities (Callaghan & Reich, 2018). Development teams consisting solely of app developers tend to engage children differently from teams containing experts (McEwen & Dubé, 2015), who are more likely to engage children effectively with learning-centered quality content (Dubé et al., 2019). Thus, app design can be greatly improved by involving educational experts in the development process (Falloon, 2013).

Despite developers knowing the importance of consulting educational experts, a large number of their products are developed without consideration of key educational factors that may affect learning (Geisert & Futrell, 1999). According to Vaala et al. (2015; 2016), less than half of the popular paid, free, and award-winning apps in Apple App Store provide information about their development teams. Further, what is mentioned is not sufficiently elaborated and is more often available on the producers' website rather than in the app descriptions itself. Findings from a recent study of the most popular math apps in the Apple App Store by Dubé et al. (2020) reveals that information regarding the development team was mentioned in 30.1% of the selected apps. Therefore, including information regarding the scientific background and the educational experience of the development team could be a great guidance for educators and parents while looking for quality educational apps.

Guiding curriculum. This benchmark refers to apps containing a clear underlying educational curriculum (i.e., a lesson or an academic program taught in school or specific course) along with explicit learning goals (Dubé et al., 2020). Walker (2011; 2013), who is known as being the pioneer in mobile application evaluation, considers connection with the curriculum as a central criterion of determining App quality. Moreover, Rosell-Aguilar (2017) builds on this by referring to "curriculum connections/relevance" as one of the most frequently mentioned criteria in frameworks for the evaluation of effectiveness of educational apps. Similarly, a guiding curriculum is regarded as one of the most important considerations for parents. They think of curriculum as a signifier of a quality app and react to the presence or absence of this benchmark while making education related decisions (Vaala et al., 2015). Accordingly, Dubé et al. (2020) noted that the presence of a curriculum in an apps' description correspond with higher user ratings of an app in the Apple App Store. As suggested by Walker (2013), when considering curriculum connections in educational apps, it is important that online and offline resources complement one another. Meaning that app content should be designed in relevance with a curriculum and thus could be used to practice the skills and concepts of the lesson being presented in the classroom, and consequently supplement classroom learning (Falloon, 2013; 2017). That is why teachers selecting and evaluating educational apps have the tendency to choose apps related to the specific subject areas or targeted skills, suiting the needs of existing competency-based curriculum in their classrooms (Falloon, 2017; Goodwin, 2012).

In addition to app's content being linked to a curriculum, a number of studies suggest that apps containing well-defined learning goals promote effective learning (Callaghan & Reich, 2018; Falloon, 2013; Hirsh-Pasek et al., 2015). Hirsh-Pasek et al. (2015) consider learning goals as the foundation of their four "pillars" of learning (i.e., active, engaged, meaningful, and socially interactive learning). They suggest that including explicit learning goals in educational apps can assist educators and parents in the process of evaluating and selecting quality apps and can navigate the students toward a clear learning path. Falloon (2013) stresses the importance of clear learning goals, structure, and guidance in developing educational apps since they encourage the learners to interact with the app content as they pursue its learning purpose. Lack of these elements may result in unproductive interactions with the app in search of entertainment and ultimately causing frustration (Falloon, 2013; Lee & Sloan, 2015).

As reported in the study by Vaala et al. (2015), less than a third of the apps in their sample (consisting of top fifty popular paid and free, and award-winning apps) mentioned having an underlying curriculum. Among those containing a curriculum in their Apple app store's description, the most commonly mentioned curriculum indicators were “Common Core”, followed by “Montessori”. However, what is worth considering by both the users and developers is that sometimes curriculum is not mentioned in an app's description but it is used either explicitly or implicitly in the development and content of the app (Papadakis & Kalogiannakis, 2017; Vaala et al., 2015). Similarly, learning goals are not often mentioned in educational app descriptions (Ok et al., 2016). Therefore, it can be concluded that educational apps developed based on an underlying guiding curriculum and including clear learning goals can be seen as quality apps that are more likely to result in meaningful learning outcomes.

Learning theory. This benchmark refers to apps being based on a particular pedagogical approach (Dubé et al., 2020). A number of studies stress the importance of utilizing learning theories and instructional strategies in the process of designing educational apps and games (Charles & McAlister, 2004; Dubé et al., 2020; Falloon, 2013; Kebritchi & Hirumi, 2008; O'Neil & Fisher, 2004; Zydney & Warner, 2016). Further, a wide range of learning theories and instructional strategies are being used to design educational apps and games. For instance; behaviourism (Highfield & Goodwin, 2013), control-value theory (Pekrun & Perry, 2014), guided discovery (Highfield & Goodwin, 2013; Hirsh-Pasek et al., 2015), situated learning theory (Zydney & Warner, 2016), embodied cognition (Dubé & McEwen, 2015), as well as direct, experiential, situated, discovery/inquiry, and constructivist approaches (Kebritchi & Hirumi, 2008). Similarly, a study conducted on the top free educational apps in Norway suggested that free apps are built on a variety of pedagogical methods. These included presentations, tutorials, gaming, demonstration, discovery, problem solving, and simulation; but, drill and practice-apps were the most common amongst free apps (Kolâs et al., 2016).

As Kolâs et al. (2016) suggest, educational apps may consist of a range of activities and different educational goals, thus, they can feature several pedagogical methods. Critically, the learning theory used to design an app must align with the app's learning goal (Dubé et al., 2020) such that the learning theory informs and shapes the design of the apps' interactions and activities (Zydney & Warner, 2016). Developing an educational app based on an underlying theoretical foundation will ensure that the app is designed with learning as its main purpose and will improve achievement outcomes (Dubé et al., 2019). Thus, possessing a central learning theory represent an important benchmark for identifying quality educational apps.

Scaffolding. The concept of scaffolding is closely linked to Vygotsky's zone of proximal development (Falloon, 2017; Sharma & Hannafin, 2007; Tabak & Kyza, 2018). ZPD indicates the range of tasks, activities or abilities that learner can perform with assistance but cannot yet perform independently (Tabak & Kyza, 2018; Vygotsky, 1978). Scaffolding refers to the titrated supports that are given to learners to assist them in accomplishing the tasks that are beyond their capability and cannot be carried out independently (Hirsh-Pasek et al., 2015; Tabak & Kyza, 2018; Wood et al., 1976). What differentiates scaffolding from other types of supports is the gradual reduction and eventual withdrawal of the scaffolds as learners gain and develop the competence to complete the task unaided (Hirsh-Pasek et al., 2015; Sharma & Hannafin, 2007; Tabak & Kyza, 2018). Therefore, fading of scaffolds results in learners' internalization and independence (Sharma & Hannafin, 2007), and leads to greater competence in self-regulation (Falloon, 2017). Scaffolding plays an important role in early learning (Neumann, 2018; Wood et al., 1976), and can be considered as one of the best ways to promote in-depth understanding and better learning (Tabak & Kyza, 2018).

Multiple studies have been conducted on how technology features can be put in use as technology-based scaffolds to assist learners (Kim & Hannafin, 2011; Sharma & Hannafin, 2007; Zydney & Warner, 2016). As stated by Sharma and Hannafin (2007), scaffolding in technology-enhanced learning environments can be referred to as “technology-mediated support”. This technology-mediated support provides a strategic framework for selecting and implementing strategies to support learners in specific learning tasks, the development of independent skills, as well as expanding their zone of proximal development (Sharma & Hannafin, 2007). Accordingly, scaffolding exists in an app when the app uses instructional techniques/ strategies as supports to guide, foster, and support the learners’ efforts as they go through the learning process (Dubé et al., 2020; Hannafin et al., 1999). Scaffolding in apps can take many forms (e.g., conceptual, procedural, strategic, Hannafin et al., 1999), but regardless of the type of scaffolds utilized in an app, providing well-timed and well-placed scaffolds that correspond to learning characteristics are key in effective scaffolding (Falloon, 2013; Zydney & Warner, 2016). Building on all the aforementioned evidence, scaffolding and providing guidance plays an essential role in supporting fruitful learning when designing learning tasks (Sharma & Hannafin, 2007) and developing educational apps (Falloon, 2013; Zydney & Warner, 2016). Therefore, Scaffolding can be considered as a promising feature for categorizing an educational app as a quality app.

Feedback. Feedback can be defined as an ongoing and consistent formative form of assessment that takes place during the learning process and provides information about the learner’s understanding or performance on a task (Pellegrino, 2018). Hattie and Timperley (2007) and Tärning (2018) define feedback as a reaction to learner’s performance and thoughts on a task. Feedback has the potential to guide learners in the right direction and promote the learning outcome (Tärning, 2018). Feedback improves the errors and omissions of learner's performance or understanding by providing them with corrective information and alternative strategies (Hattie & Timperley, 2007; Petty, 2009). In fact, feedback can also be delivered in the form of positive reinforcement by telling learners about their success and what they have done well (Hattie, 1999).

In order for feedback to be more beneficial, it is important for it to be informative rather than evaluative (Petty, 2009). Thus, it is recommended to provide learners with detailed informative feedback (i.e., explanatory feedback) to fill the gap between what is understood and what is needed to be understood, even on well-performed tasks (Hattie & Timperley, 2007; Petty, 2009; Sadler, 1989). Indeed, feedback can only result in learning gains if it includes guidance and information on how to improve (Cayton-Hodges et al., 2015; Kluger & DeNisi, 1996; Petty, 2009). Regular and formative feedback augments learning, enhances learners' achievement (Hattie & Timperley, 2007; Petty, 2009), lessens the cognitive load on learners (Tärning, 2018), promotes independence (i.e., not requiring teacher or peer support) (Falloon, 2017), and aids in problem solving (Handal et al., 2013).

In terms of educational apps, employing high-quality and effective feedback is central to successful learning (Cayton-Hodges et al., 2015; Kay, 2018; Tärning, 2018). Feedback can provide the learner with the formative guidance needed when exploring a learning environment (Tärning, 2018). It can tailor the learning experience (e.g., by providing learners with the same or individualized feedback) and foster a guided approach, which results in lower cognitive load of learners while interacting with the apps content (Tärning, 2018). High-quality feedback is timely, process orientated, and relevant to the input and content of the app (Cayton-Hodges et al., 2015; Dubé et al., 2020). Utilizing effective feedback creates the opportunity for learners to discover, learn and correct their mistakes which eventually results in deeper learning of the subject matter (Kay, 2018; Petty, 2009). Since meaningful and effective feedback can intensify the learners' attention and extend their engagement on the app experience (Hirsh-Pasek et al., 2015), its inclusion becomes particularly important for instructive, constructive, practice-based and game-based apps (Kay, 2018). As stated by Blair (2013), feedback can be delivered in different forms, therefore app developers should make the decision on what kind of feedback will maximize and augment learning and engagement in their particular context, as well as their targeted age group (Callaghan & Reich, 2018). Accordingly, app studies have identified many different types of feedback (e.g., status, corrective, conceptual, verification, corrective, elaborated, encouraging, and result, Cayton-Hodges et al., 2015; Tärning, 2018). Regardless of the types, feedback is an essential aspect of the learning process (Callaghan & Reich, 2018; Dubé et al., 2020; Kay, 2018; Tärning, 2018) and a combination of different types of feedback contribute to positive learning outcomes (Callaghan & Reich, 2018; Cayton-Hodges et al., 2015). Since the lack of feedback in educational apps is considered a major flaw in most commercial educational apps (Cherner et al., 2014), the inclusion of feedback should be considered a meaningful benchmark of educational quality.

Educational Benchmarks vs. Educational Buzzwords

As apps have become a growing educational medium (Shuler et al., 2012), educators and parents are searching the App Store in hopes of finding the best possible apps in which to invest their children's time and energy, as well as their own money. Apps can benefit learning if they contain quality educational content (Hirsh-Pasek et al., 2015; Dubé et al., 2020). However, as discussed earlier, there are major issues that educators and parents face while selecting apps. These include the lack of quality information in the text descriptions and images provided in the

App Store (Dubé et al., 2020; Larkin, 2013) and the absence of any standardized criteria for determining a quality educational app (Papadakis & Kalogiannakis, 2017). Larkin (2013) refers to information (i.e., app descriptions) provided by app developers as “infomercial”, as they only have commercial use and are merely mentioned to promote and sell the apps (cf., focusing on educational aspects). Educators and parents usually consult websites or blogs while selecting apps (Papadakis & Kalogiannakis, 2017). Therefore, app developers and companies typically try to promote their apps based on naïve perception of public opinion and guidelines provided by popular developer and educators websites. These guidelines suggest that educational apps should entertain and engage the learner, have fun and interactive content, integrate social media, and provide personalized learning experience (Mahajan, 2019; Rajput, 2017). As a result, many developers rely on bombarding their audience with buzzwords to promote their products. Words and phrases like entertaining, interactive, multi-media, hands-on experience, engaging, and personalized learning are frequently used in the educational app marketplace (Mahajan, 2019; Rajput, 2017). In contrast, research shows that the images and text descriptions used to advertise apps do not often contain the aforementioned educational benchmarks (Dubé et al., 2020; Vaala et al., 2015). Apparently, the solution to this problem lies in the educators’ and parents’ prior knowledge of the indicators of educational quality and their ability to differentiate them from these vague, valueless buzzwords. It is therefore crucial to investigate educators and parents’ educational app selection decisions to determine if they are choosing apps based on research supported educational benchmarks or common educational buzzwords.

Summation

There are five benchmarks that have the potential to augment an apps’ educational value and increase learning outcomes (Callaghan & Reich, 2018; Cayton-Hodges et al., 2015; Dubé et al., 2020; Kebritchi & Hirumi, 2008; Vaala et al., 2015). The presence of the above-mentioned benchmarks can be indicative of an app's quality (Dubé et al., 2020; Vaala et al., 2015) and research concludes that the App Store does not provide enough information on benchmarks (Dubé et al., 2020; Larkin, 2013; Vaala et al., 2015). Therefore, inclusion of these five benchmarks in the apps' text descriptions and images should provide educators and parents with the information needed to make an informed decision. However, it is not yet known whether educators and parents look for these benchmarks while selecting a quality educational app or not.

The Current Study

To the best of our knowledge, to date no research has been done on how educators select educational apps from the App Store to use in their classrooms (Dubé et al., 2020). Similarly, there is a lack of research on how parents select educational apps for their children to use at home (Broekman et al., 2016). The present study addresses these gaps in the literature by developing novel procedures and measures to investigate educator and parent app selection process.

According to Dubé et al. (2020), the five educational benchmarks are not frequently present in app descriptions. The current study builds on this previous work by investigating whether the presence or absence of these educational benchmarks in App Store app descriptions affects educators and parents' app selection. Educator and parent app selection will provide insights into their TPACK and app specific needs, respectively. Further the study will investigate which aspects of app pages inform educators app selection (i.e., text description of apps or images of apps). As such, the current investigation consisted of two studies: Study 1 with educators (lab-based using eye tracking) and Study 2 with parents (online without eye tracking). In both studies, participants are shown 10 simulated educational apps (5 benchmark apps, 5 buzzwords apps) and asked to evaluate them. The two studies use identical designs and stimuli but differ in population (educators vs parents), delivery method (lab vs online), and measurement (eye tracking present vs absent).

Study 1: Educator Study

The educator study was guided by the following research questions:

RQ1: To what extent do educators possess technological knowledge (TK) for educational apps (i.e., valuing benchmarks over buzzwords)?

RQ2: If educators are valuing educational benchmarks, which ones do they value more?

RQ3: Where do educators look to gather information (i.e., text descriptions or images)

Method

Participants

Participants included 57 English-speaking graduate and undergraduate students enrolled at McGill University. Following approval by the Research Ethics Board of McGill University, working and pre-service teachers were recruited from both undergraduate and graduate courses in the Faculty of Education from teaching related programs. Participant recruitment took place during the first weeks of the Fall 2019 and Winter 2020 academic semesters. Emails were sent to course instructors and they were asked to enroll their classes in the study participant pool. Once permission was granted by the instructor, participant recruitment was carried out by a brief presentation made at the start of their class explaining the purpose of the study and then a sign-up sheet was distributed. Participants were also recruited through posters placed around the university campus in coordination with the McGill Campus Life and Engagement office (see Appendix A). Prior to study participation, all volunteers were confirmed as working and pre-service “elementary” teachers. Written consent was obtained immediately prior to data collection (see Appendix B). Participants were compensated with $10 CAD in cash.

Demographic responses showed 89.5% of participants identify as female and 10.5% as male, with participants’ mean age being 22.74 years (*SD* = 4.39) and ranging from 19 to 43 years old. Participants’ ethnicities were primarily White (61.4%), followed by Asian or Pacific (15.8%). Participants consisted of working (12.3%) and pre-service (87.7%) elementary teachers. For working teachers, the mean number of years worked was 4.14 years (*SD* = 2.35) and ranged from 1 to 8 years of experience. The subjects taught by participants were diverse, including Math, Science, and English.

Procedure

Data was collected in individually-administered sessions in the Technology, Learning, and Cognition lab located in the Faculty of Education building at McGill University. Participants were seated in a chair approximately 60 to 65 centimeters from an Apple iMac desktop computer with a 60 Hz Tobii Pro Nano eye-tracker affixed directly below the screen (see Figures 4 & 5). This specific distance was used to support optimal eye tracking (Tobii, 2020). Then, the researcher confirmed the participant could comfortably read the text on the screen, reach the keyboard and mouse, and was in a comfortable posture that could be maintained for the duration of the experiment. Participants were also instructed to avoid rapid head movements and not to turn their heads too drastically from the screen during the experiment, since the eye tracker can only follow eye movements within the eye tracker’s trackable area.

Figure 4. Tobii Pro Nano eye tracker

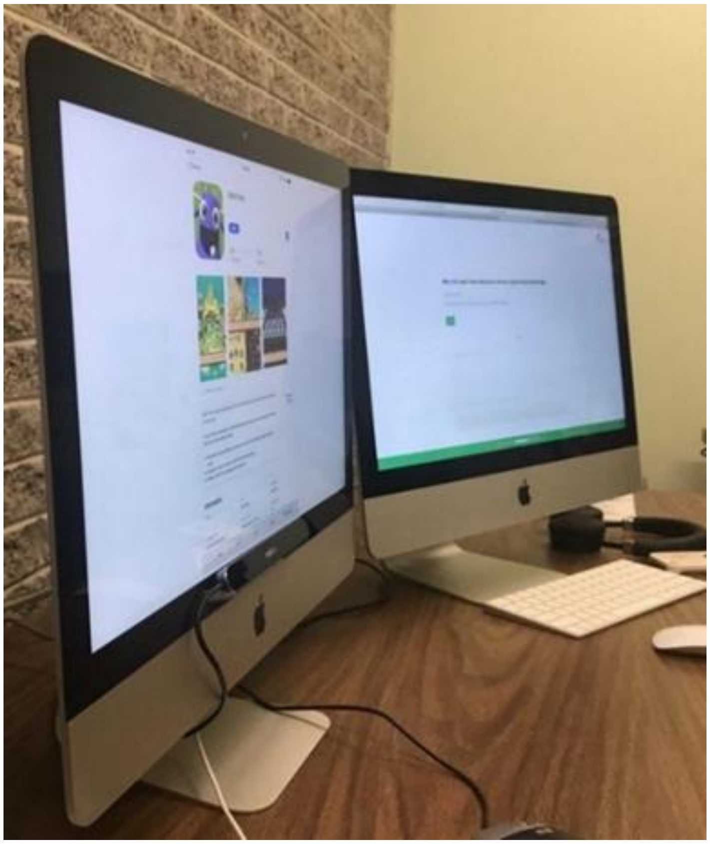

Figure 5. Two Apple iMac desktop computers with Tobii Pro Nano eye tracker in the lab room

Once properly seated, participants provided demographic information (via a digital survey distributed on an adjacent iMac programmed using SurveyMonkey) (see Appendix C), and then proceeded to eye tracking calibration. During calibration, participants were instructed to look at targets appearing at multiple locations on the screen while the eye tracker triangulates their gaze position for each location (a nine-point calibration was conducted across the same location as where the stimulus was to be displayed on the screen). After a successful calibration (i.e., degree of validation accuracy less than 0.80), participants were reminded that they would see a sequence of 10 math apps while their gaze data was recorded with the eye tracker. Apps were presented one at a time using the Tobii Pro Lab software and participants had unrestricted time to view each app (i.e., text descriptions & images). Immediately after viewing each app, participants evaluated the app by answering four questions on the adjacent iMac. After viewing and evaluating all 10 apps, participants ranked the 10 apps from best to worst. To account for order effects, the order of the apps was counterbalanced across four different timelines. The assignment of four timelines to participants was done chronologically (i.e., participant 1: timeline 1, participant 2: timeline 2, …., participant 5: timeline 1, participant 6: timeline 2).

Materials

Math applications. Ten simulated educational mathematics applications that replicate the Apple App Store presentation were designed to be used as the stimuli in the study (see Appendix D). These 10 math apps were formatted identically to how they are depicted in the Apple App Store but systematically altered to vary the presence or absence of educational benchmarks. Five of these apps included one of the key educational benchmarks embedded in their text descriptions and images while the other five contained educational buzzwords. The written descriptions for all apps were designed to be as similar as possible; all start with a 2-3 introductory sentences, contain 3 bullet points, and contain a similar number of words and characters (see Table 1). The average number of characters (without spaces) in the benchmark descriptions (M = 359.6, SD = 27.2) does not significantly differ from the buzzword descriptions (M = 363.4, SD = 26.1), p = .42 (see Table 2). For the images, 10 existing math apps were selected from the Apple App store that had app images similar in visual complexity and style (see Dubé et al., 2020). The apps were then randomly assigned to be either a benchmark or buzzword app. The app images from these apps were altered to include text referencing their respective benchmark or buzzword.

Table 1

Written Descriptions of Ten Simulated Mathematics Applications

App Name	Text Description
	Benchmarks
App 1: Space Math (Scaffolding)	"Our game makes math out of this world. Space Math helps to boost kid's confidence, increase math performance, and get ahead in math. Space Math reinforces math concepts using self-paced and adaptive practice. **Space Math reinforces key math skills with math questions that adapt to your child ** Space Math offers hints when kids need help ** Kids get guided practice to help improve their math skills"
App 2: King of Math (Curriculum)	"In our app, math has become an exciting and fun adventure! King of Math helps kids master math skills and develop their interest in mathematics. King of Math is a comprehensive program based on a formal math curriculum. **This app is aligned with the Common Core State Standards **Based on the Common Core State Standards, kids will learn math skills at their grade level **Includes a Report Card section where parents and teachers can see curriculum progress."
App 3: It's Math Time (Development team)	"Our app helps your kid enjoy math. It's Math Time offers an exciting journey of math practice, enhancing kids' confidence and skills in math. Its Math Time is developed by certified experts in child development and math educators **This app is developed by researchers from world-class universities **This app was tested by teachers **This app is approved by experienced educators"
App 4: Magical Math Bird (Feedback)	"Magical Math Bird makes math soar. Kids can gain confidence in mathematics while increasing their math performance and improving their math skills. Magical Math Bird helps kids understand mathematical concepts by providing feedback. ** This app gives immediate feedback, stating whether your child's answer is correct ** This app enhances learning by explaining wrong answers ** This app provides corrective feedback to help guide kids towards the right answer"
App 5: Let's Play Math (Learning theory)	"Math is all fun and games with us. Let's Play Math helps kids understand math, improves children's math performance, and enhances their confidence. Let's Play Math is created using an evidence-based theory for how children learn math. ** This app's learning theory is based on discovery and experimentation **In the theory, kids learn math by solving equations through play **The theory helps kids learn at their own pace."

Buzzwords

App 6: Math Monster (Interactive)	"Have fun with math in Math Monster! Kids become more confident and perform better after interacting with Math Monster. Math Monster is a fully interactive learning experience. ** Kids quickly place sushi pieces near the monster to match the target number ** By listening and responding to the math monster kids become math masters ** Kids earn points, stars, trophies, and personal bests to challenge themselves and unlock new levels."
App 7: Be A Math Star (Multi-media)	"Give your kids a solid math foundation with Be a Math Star. This app makes it easy and fun for your kids to enter the wonderful world of math. Be a Math Star uses multi-media to bring math to life; turning numbers into colorful and real-life elements and representations. ** The app contains visual and audio activities to explore math ** Kids get star points as they progress and feel like a real star ** Kids acquire their ability to match numbers to what they see and hear"
App 8: Math Fox (Hands-on)	"Experience a day with Math Fox? Would you like to solve puzzles with Math Fox while practicing math? Math Fox is a hands-on learning experience; your child will be delighted while getting a head start in school. **Kids solve math puzzles with hands-on activities **By moving number blocks, kids solve math problems with their hands **Kids are delighted by animations that respond to their touch"
App 9: Math Zombies (Engaging)	"Use your math skills and math-powered super moves to save the zombies. Beat the brain-dead and save the world with Math Zombies. Math Zombies is a learning game that engages your child with math. Watch as they can't peel their eyes away from math! **Kids are engaged by funny characters and rich game environments **Kids get better and faster at math while exploring new worlds that keep them playing **Kids can strengthen and practice their math skills while having fun"
App 10: Math Party (Personalized)	"Math Party makes learning math truly fun and simple for your kids! Throw a monster of a math party! A very personal experience. In Math party, your child builds a custom island and throws their own math monster parties. **Kids solve math problems, earn points, and use them to build a custom monster island **Kids earn unique monsters and throw monster parties **Makes math fun by making math personal"

Table 2

Written Descriptions' Parameters of Ten Simulated Mathematics Applications

Math Apps	Benchmark/ Buzzword	Number of Words	Number of Characters		Number of Bullets
			With Spaces	Without Spaces	
Scaffolding	Benchmark	67	404	338	3
Curriculum	Benchmark	78	463	386	3
Development team	Benchmark	60	382	323	3
Feedback	Benchmark	69	462	394	3
Learning theory	Benchmark	68	424	357	3
Interactive	Buzzword	70	434	367	3
Multi-Media	Buzzword	88	477	390	3
Hands-on	Buzzword	65	394	332	3
Engaging	Buzzword	80	472	393	3
Personalized	Buzzword	69	403	335	3

Measures

Participants' judgements of the apps were measured using eye tracking and evaluation questions. The eye tracking metrics reported in the present study were chosen based on previous eye tracking studies (Duchowski, 2007; McEwen & Dubé, 2015; Rayner, 1998; Sharafi et al., 2015b; Sharafi et al., 2015a). Similarly, the value judgements were chosen based on previous educational app studies (Dubé et al., 2020; Papadakis & Kalogiannakis, 2017; Papadakis et al., 2018).

Eye tracking measures. Eye trackers are used in cognitive psychology to study information processing tasks and gain deeper understanding of cognitive processing (Rayner, 1998). During the study, the eye tracker records the participant's visual attention by collecting eye-movement data including where the participant is looking, the duration, and also the sequence in which their attention switches from one location on the stimulus to another

(Duchowski, 2007; Rayner, 1998; Sharafi et al. ,2015b). The collected gaze data of participants can be used to understand their cognitive processes during reasoning tasks (Sharafi et al., 2015a); in this case, evaluating educational apps.

To measure and compare gaze data across different parts of the stimuli, each math app was divided into Areas of Interests (AOIs). AOIs are drawn around regions in a stimuli and facilitate statistical and visual comparisons between these regions. According to Goldberg and Helfman (2010), defining appropriate AOIs is a principal step for analyzing eye tracking data. However, there are no rules or guidelines about how to define them. In fact, defining AOIs is a subjective task and depends on the nature and goals of the study (Sharafi et al. ,2015b). As such, five identical AOIs were defined and drawn around the same parts of all 10 apps (i.e., icon, title, image, text, textinfo, see Figure 6). The eye tracking metrics were calculated for the defined AOIs of the stimuli, as well as for the stimuli in total (i.e., inside or outside of the AOIs). The final data was an aggregate of the recorded gaze data from which the “Fixations” for every single AOI were measured.

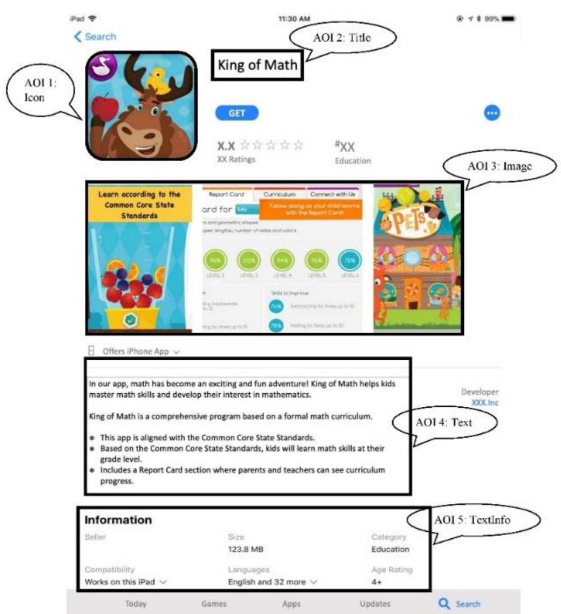

Figure 6. Five AOIs on simulated math app

A fixation can be defined as the stabilization of the eye on a part of the stimulus for a period of time (Sharafi et al., 2015b). Most information acquisition and cognitive processing occurs during fixations (Sharafi et al., 2015a). There are different assumptions regarding the relationships between fixations and cognitive processes. Just and Carpenter (1980) discuss two assumptions. The immediacy assumption holds that the participant interprets the word in the text (i.e., encoding the word, choosing one meaning of it, assigning it to its referent) as soon as they encounter it. The eye-mind assumption holds that the participant's eyes and attention fixate on the word until it is being processed or comprehend, which is directly associated with the gaze duration. Further, there is also the notion that areas with longer fixations are more noticeable or important to the participant than the other areas of the stimulus (McEwen & Dubé, 2015; Poole et al., 2005). Fixation-based metrics have mostly been used where researchers are interested in calculating data for specific AOIs (Sharafi et al., 2015b). Therefore, participants' recorded gaze data were investigated based on two measures with respect to the AOIs; fixation count and fixation duration. Also, Heat maps generated by the Tobii Pro Lab software were used as a type of visualization technique to gain better insight into participants' visual gaze behavior (Tobii Pro 2020).

Fixation count. Fixation count is measured by counting the number of fixations within specific AOIs or the whole stimulus (Sharafi et al., 2015a, Tobii Pro 2020). Interpreting the meaning of fixation counts depends on the nature of the task being performed (Poole & Ball, 2006; Sharafi et al., 2015a). For tasks that involve browsing (i.e. scanning the content and gathering relevant information), higher fixation counts for a specific AOI indicates that the participants show greater interest in that AOI (Jacob & Karn, 2003; Sharafi et al., 2015a). Therefore, fixation counts can indicate where and how often participants have looked at different parts of the stimuli to gather the required information (i.e., AOIs including benchmarks vs AOIs including buzzwords and image vs text description).

Fixation duration. Fixation duration is measured by calculating the total time of all fixations for a specific AOI or the whole stimulus (Sharafi et al., 2015a, Tobii Pro 2020). According to Sharafi et al. (2015a), longer fixation duration in an AOI reveals that participants spend more time analyzing and interpreting its content. Fixation duration can also be used to compare the amount of attention on different AOIs or stimuli (Poole & Ball, 2006; Sharafi et al., 2015a). Thus, fixation duration indicates where participants have looked longer to gather the required information (i.e., AOIs including benchmarks vs AOIs including buzzwords and image vs text description).

Heat maps. Heat maps are data visualizations that can manifest important aspects of the participants' visual behavior in a clear way and demonstrate where participants have been looking and how looking is distributed over the stimulus (Tobii Pro 2020). Moreover, heat maps can reveal the focus of visual attention for a number of participants at a time (Tobii Pro 2020). A heat map is a color spectrum that represents the intensity (number and duration) of fixations (Sharafi et al., 2015a). Different colors are used in a heat map to illustrate the number of fixations participants made within certain areas of the stimulus or for how long they fixated within that area (see Figure 7). The color red indicates higher fixation counts or longer fixation durations, whereas green indicates the least (Tobii Pro 2020). However, heat maps are seldom the most meaningful output from an eye tracking study because improperly interpreted heat maps can be misleading (Tobii Pro 2020). In this study, heat maps were used to inform the interpretation of the analyses of the fixation count and duration data.

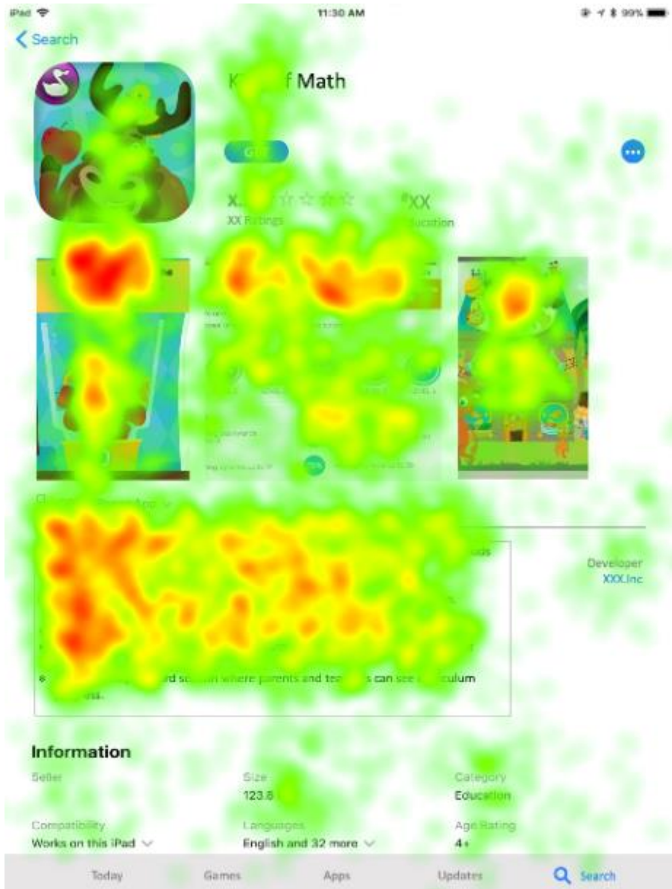

Figure 7. Generated heat map on a simulated math app

Value judgements. Participants provided value judgements for each app to measure whether they value apps including benchmarks more than ones including buzzwords. Value judgements consisted of four measures that mirror how educational app users typically evaluate apps in the App Store. App stores grant users the opportunity to express opinions and submit feedback in the form of star ratings and text reviews for downloaded apps (Guzman & Maalej, 2014). User reviews are a key component in app markets (Malik & Shakshuki, 2016), as they are used by app developers and companies to observe app users' behaviours and sentiments (Bano et al., 2017; Guzman & Maalej, 2014). Reviews also influence decision making of other potential users, as they read reviews and gain insight into the apps before buying or downloading them

(Malik & Shakshuki, 2016). As such, reviews represent a "voice of the users" (Maalej & Pagano, 2011) and participants should be familiar with making these types of judgements.

Would you download this app? YES/ NO. There is a connection between the popularity of an app and its number of downloads (Papadakis et al., 2018), with the higher number of cumulative downloads indicating its popularity among users (Papadakis & Kalogiannakis, 2017). In fact, Papadakis et al. (2018) found that most users who downloaded an app had a positive or very positive attitude towards the app. As such, this question measures participants' willingness to download a given app with greater willingness also indicating a positive evaluation of the app.

How much would you be willing to pay? (free- $30). The majority of non-educational apps are free to download, but the average price of payed apps in the Apple App Store is around $1.32 CAD (Statista, 2019). For educational apps, the numbers are remarkably different; only 16% of the top 90 educational math apps in the App Store are free and the average price of a payed app is $14.48 CAD (Dubé et al., 2020). Clearly consumers are willing to pay more for educational apps than the typical app. As such, this measure was used to gauge how much participants are willing to pay for these math apps with greater amounts indicating more positive evaluations.

How would you rate this app? (1-5 stars**).** User ratings are a way of assessing an app's quality based on the opinions of those who have already downloaded an app (Dubé et al., 2020). According to the App store's 5-star rating system, apps with higher ratings are considered as popular among users (Papadakis & Kalogiannakis, 2017; Papadakis et al., 2018). As such, this question measures how participants rate apps with higher ratings indicating more positive evaluations.

What reason do you have for downloading this app or not (open ended response)? The App Store allows users to share their opinions in form of text reviews for downloaded apps (Guzman & Maalej, 2014). This information is useful for app developers to gain insights into consumers' behaviours and attitudes (Bano et al., 2017; Guzman & Maalej, 2014). Written reviews can include ideas for improvements and sentiments about specific features (Bano et al., 2017; Guzman & Maalej, 2014). Accordingly, this question enables participants to elaborate the reasons why they decided to download the app or not. In the present study, participants spontaneous mention of the benchmarks or buzzwords as reasons for downloading an app were measured.

Ranking. As the final step of the experiment, participants were presented with all 10 apps and asked to rank order them from best to worst (i.e., 10: best) with higher rankings indicating a more positive evaluation. This was done so that participants would directly compare each app and be forced to make clear distinctions between apps.

Results

RQ1: To what extent do educators possess technological knowledge (TK) for educational apps (i.e., valuing benchmarks or buzzwords more)?

Paired sample *t*-test were conducted to identify whether educators are valuing benchmarks or buzzwords. Four paired sample *t*-test were conducted on the average of four measures: download, cost, rate, and rank (i.e., download: percentage of download frequency based on yes or no; cost: average price from free to thirty dollars; rate: average rating from zero to five stars; rank: 1 to 10, 10 being the best). To compare benchmarks and buzzwords, the average of these four value judgements measures were calculated for all benchmark apps combined and for all buzzword apps combined (i.e., interactive, multi-media, hands-on, engaging, personalized).

Results showed significant differences for each measure (an alpha level of .05 for all statistical tests were used). Educators were willing to download apps containing benchmarks (*M* = 84.21%, *SD* = 15.91) more than those containing buzzwords (*M* = 64.56%, *SD* = 22.04), *t*(56) = 5.47, *p* = .000. For cost, educators reported being willing to pay more for benchmark apps (*M* = $4.69, *SD* = 4.18) than buzzword apps (*M* = $2.67, *SD* = 3.22), *t*(56) = 6.00, *p* = .000. Similarly, educators rated benchmark apps (*M* = 3.69, *SD* = .58) higher than buzzword apps (*M* = 3.11, *SD* = .68), *t*(56) = 6.18, *p* = .000. Finally, educators ranked apps containing benchmarks (*M* = 6.20, *SD* = 1.19) above those containing buzzwords (*M* = 4.80, *SD* = 1.19), *t*(56) = 4.43, *p* = .000. Overall, all four value judgements measures indicate that educators valued educational benchmark apps over buzzword apps.

Using a digital text-mining tool, a text analysis was conducted on educators' responses to the open-ended question "what reason do you have for downloading this app or not". Specifically, the relative frequency with which educators spontaneously mentioned the benchmarks and buzzwords in their answer was compared between benchmark and buzzword apps (see Figure 8 & 9). A visual analysis of the relative frequency reveals that educators spontaneously cited educational benchmarks more than buzzwords. Further participants cited feedback and curriculum as the first and second most frequent word among educational benchmarks, while interactive and engaging were the most frequent buzzwords. Interestingly, benchmarks are not frequently cited as reasons for selecting or not selecting a buzzword app (e.g., "This game does not have a curriculum") but buzzwords are cited with greater frequency as reasons for selecting benchmark apps (e.g., "It seems engaging")

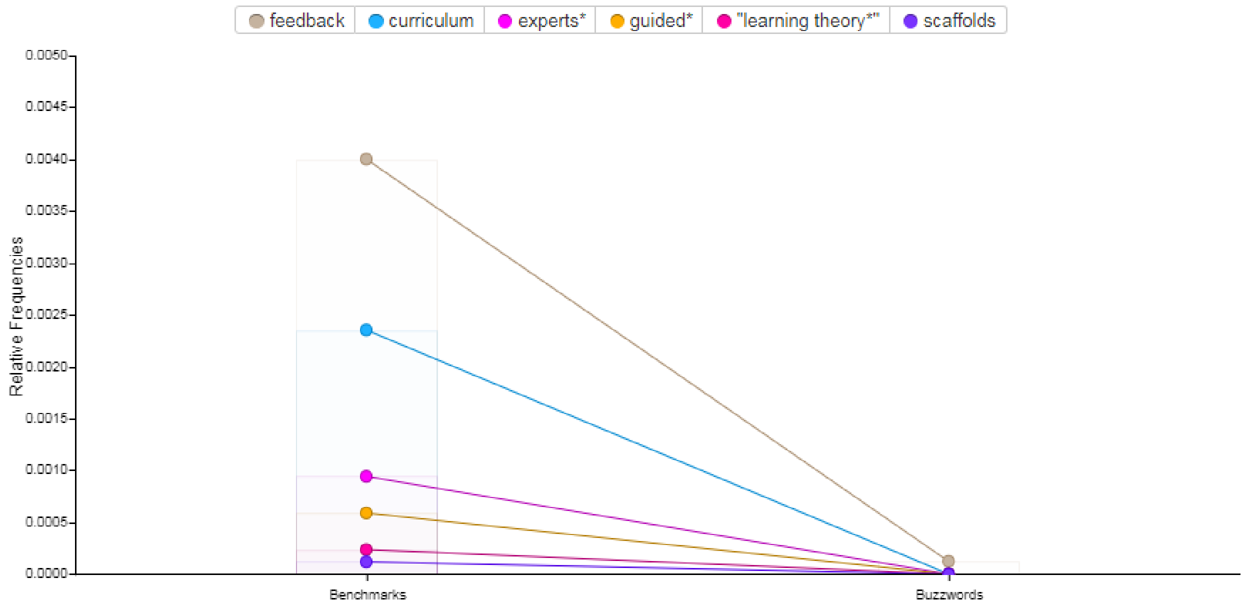

Figure 8. Educators' graph of word frequency of educational benchmarks.*

*Note. The term 'guided' was used by educators as an alternative to 'scaffold'

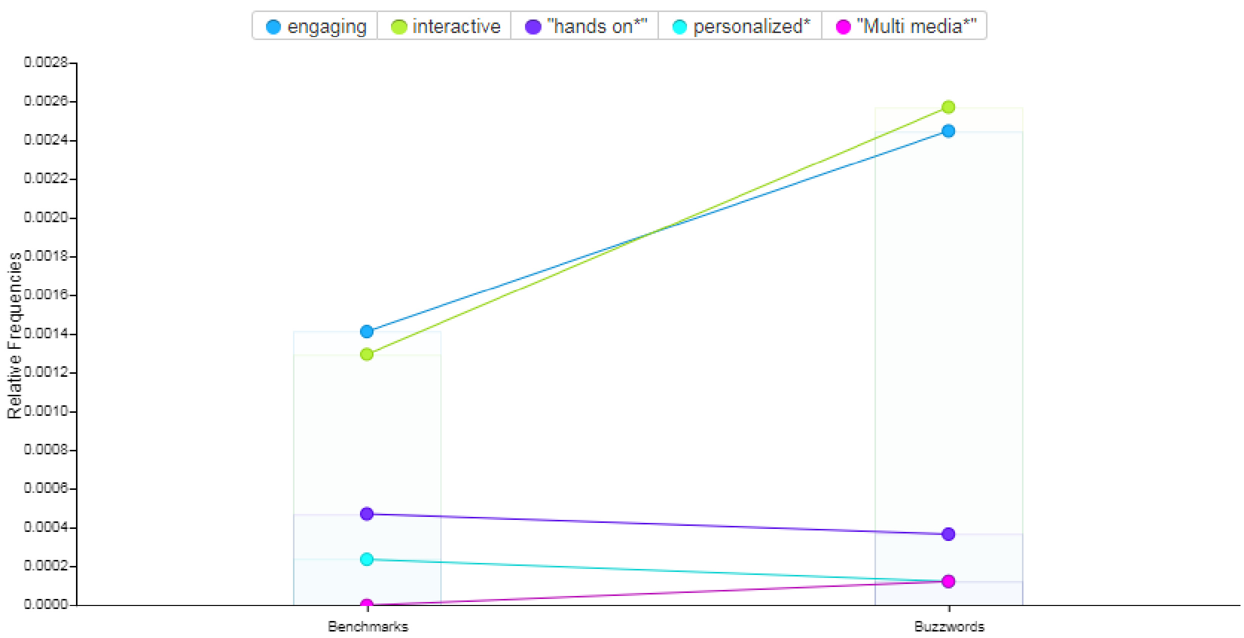

Figure 9. Educator's graph of word frequency of buzzwords

RQ2: If educators are valuing educational benchmarks, which ones do they value more?

Based on the results of research question one, it was determined that educators valued apps containing educational benchmarks over those containing buzzwords and that they spontaneously cited some benchmarks more than others. To further investigate which of the five benchmarks (i.e., scaffolding, curriculum, development team, feedback, learning theory) were valued more, repeated-measures within-subjects ANOVAs were conducted on all four value judgements measures (i.e., download, cost, rate, rank) for these benchmarks. In cases that data failed to meet the assumption of Sphericity, Greenhouse-Geisser correction was used to correct for violation of Sphericity assumption and decrease the risk of type I error. Pairwise Comparisons with Bonferroni correction were then used to identify differences among the five benchmarks.

Educators were willing to download some benchmark apps more than others, $F(3.39, 190.35) = 4.92$, $MSE = .14$, $p = .002$. Pairwise comparisons revealed that the learning theory app was less likely to be downloaded than the scaffolding ($p = .007$) and development team ($p = .012$) apps. Overall, the scaffolding app and development team app had the highest download frequency while learning theory had the lowest download frequency among all the benchmarks (see Figure 10).

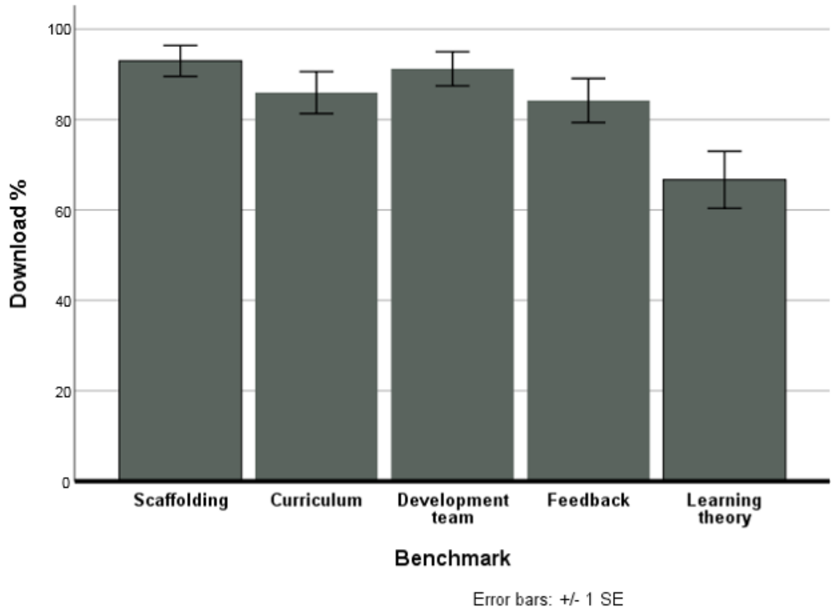

Figure 10. Differences among the five benchmarks for “Download” measure (Study 1)

A first it appears that there a was difference among the benchmark apps in terms of how much educators are willing to pay, $F(3.17, 177.81) = 2.99$, $MSE = 22.63$, $p = .03$. However, the pairwise comparisons only revealed a non-significant trend ($p = .07$) for educators being willing to pay more for the development team app than the learning theory app (see Figure 11).

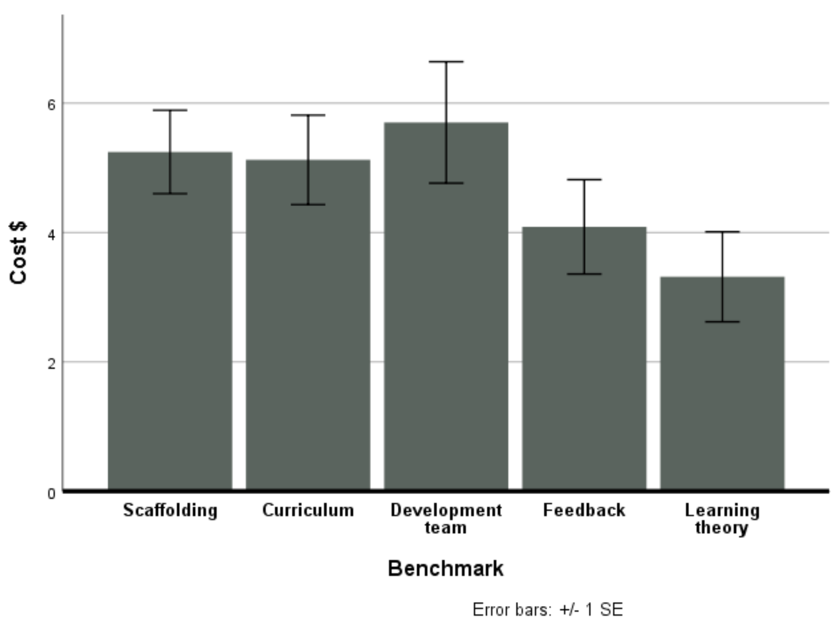

Figure 11. Differences among the five benchmarks for “Cost” measure (Study 1)

Educators rated some benchmark apps higher than others, $F(4, 224) = 8.62$, $MSE = .80$, $p = .000$. Specifically, educators rated the learning theory app lower than the scaffolding ($p = .000$), curriculum ($p = .001$) and development team ($p = .002$) apps. There is also rated the feedback app lower than the scaffolding app ($p = .018$). Overall, educators rated the scaffolding app the highest, followed by curriculum, development team, and feedback while learning theory received the lowest rating (see Figure 12).

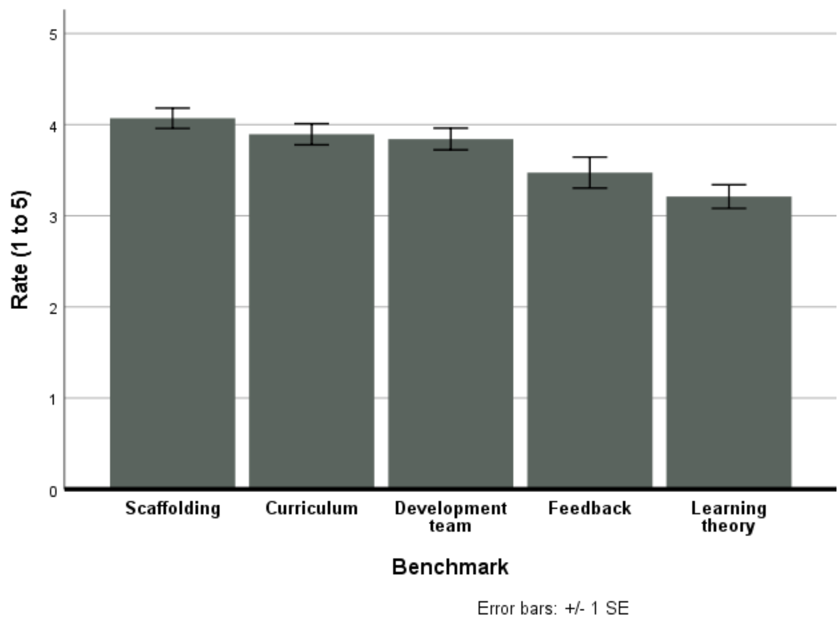

Figure 12. Differences among the five benchmarks for “Rate” measure (Study 1)

Educators ranked some benchmarks apps higher than others, $F(4, 224) = 12.07$, $MSE = 6.71$, $p = .000$. Feedback was ranked lower than scaffolding ($p = .020$), and lower than development team ($p = .003$). Learning theory was ranked lower than scaffolding ($p = .000$), curriculum ($p = .000$), and development team ($p = .000$). Development team received the highest ranking from educators and was followed closely by scaffolding while learning theory was ranked the lowest (see Figure 13).

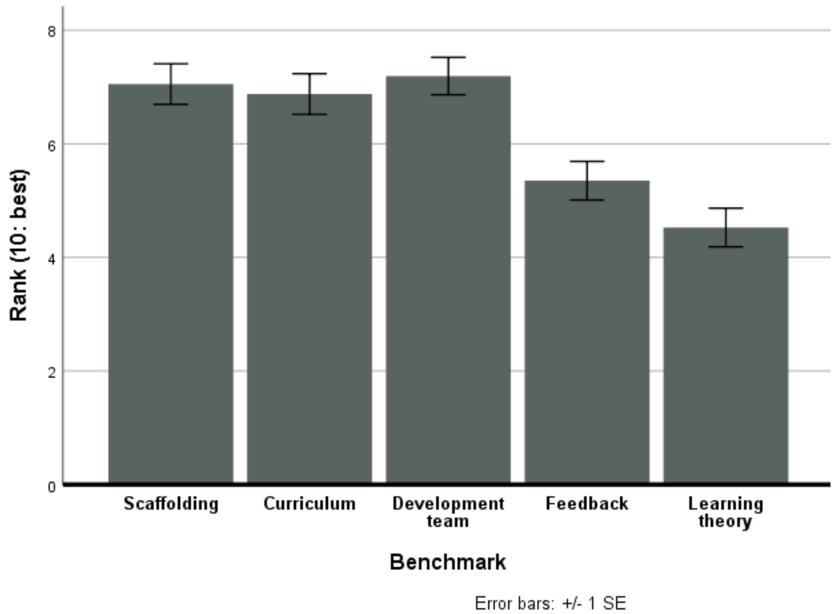

Figure 13. Differences among the five benchmarks for "Rank" measure (Study 1)

RQ3: Where do educators look to gather information (i.e., text descriptions or images)?

To check the overall distribution of the gaze data, two 2 (app type: benchmark, buzzword) x 5 (AOIs: icon, title, image, text, text info) repeated measures within-subject ANOVAs were conducted on fixation count $F(1.53, 86.13) = 18.84$, $MSE = 26.60$, $p = .000$, and fixation duration data $F(1.45, 81.18) = 31.78$, $MSE = 32.06$, $p = .000$. The fixation count and duration data are reported here as percentages (i.e., 45% means 45% of overall fixation counts and duration). Result indicate that only the image and text AOIs received sufficient attention from participants. As such, only these two AOIs were used in further analyses (see Figure 14-15).

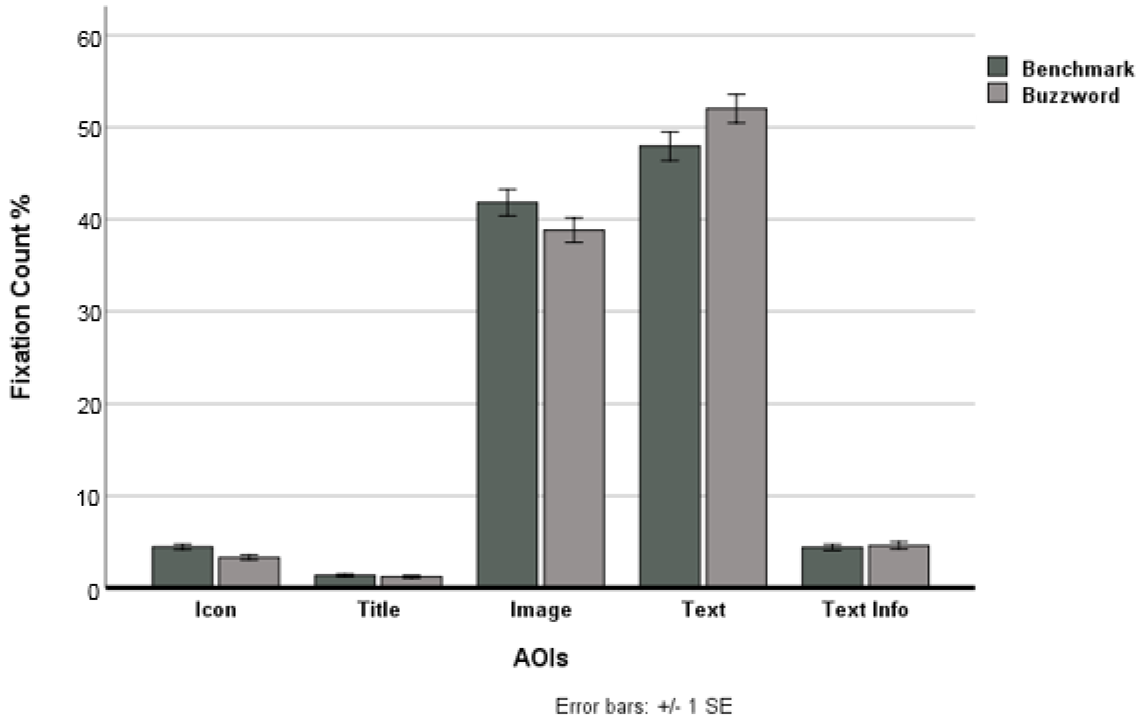

Figure 14. Differences among the five AOIs for “Fixation count” measure

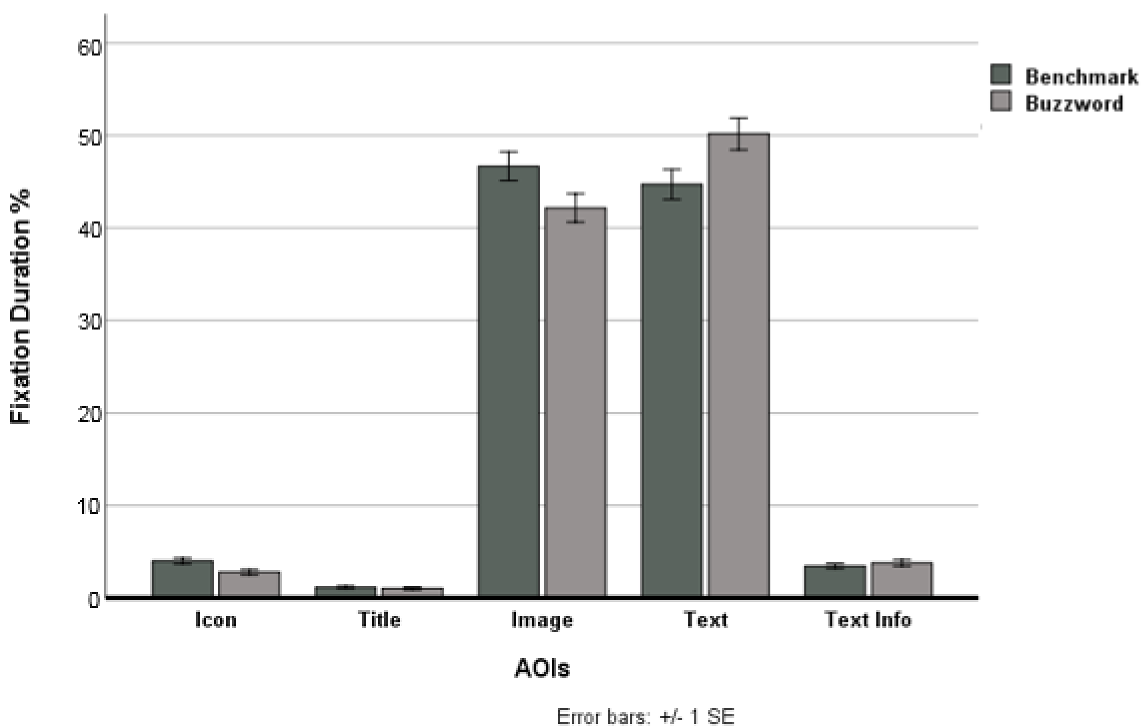

Figure 15. Differences among the five AOIs for “Fixation duration” measure

To determine whether there were differences between educational benchmark apps and buzzword apps in where educators were looking to gather information (i.e., text descriptions or images), two 2 (app type: educational, buzzword) x 2 (location: image, text) repeated measures within-subject ANOVAs were conducted on fixation count and fixation duration data.

For fixation count, the results showed a main effect of app type, with greater fixation counts for buzzwords (M = 45.42) than educational benchmarks (M = 44.89), $F(1, 56) = 5.31$, MSE = 3.06, p = .025. There was a significant main effect for location, with greater fixation counts for text (M = 49.98) than for images (M = 40.33), $F(1,56) = 11.94$, MSE = 445.28, p = .001. These main effects were augmented by a significant App type X Location interaction, $F(1, 56) = 22.21$, MSE = 32.22, p = .000. Educators looked more at images featuring educational benchmarks (M = 41.83, SD = 10.90) than images featuring buzzwords (M = 38.82, SD = 10.05), p = .000. In contrast, educators looked more at text descriptions containing buzzwords (M = 52.02, SD = 11.66) than those containing benchmarks (M = 47.95, SD = 11.73), p = .000. Thus, educators seem to draw information from different locations based on benchmark type.

For fixation duration, the results showed a main effect of app type with greater fixation duration for buzzwords (M = 46.16) than educational benchmarks (M = 45.69), $F(1, 56) = 4.54$, MSE = 2.85, p = .037. The main effect of location was not significant $F(1,56) = .96$, MSE = 541.58, p = .330, with fixation duration for text (M = 47.44) similar to that of images (M = 44.41). There was a significant App type X Location interaction, $F(1, 56) = 37.38$, MSE = 37.98, p = .000. Educators looked longer at images featuring benchmarks (M = 46.67, SD = 11.77) than images featuring buzzwords (M = 42.15, SD = 11.66), p = .000. Oppositely, they looked longer at text descriptions featuring buzzwords (M = 50.17, SD = 13.01) than those featuring benchmarks (M = 44.71, SD = 12.31), p = .000.

In order to demonstrate where participants have been looking and how looking was distributed over all 10 apps, heat maps of the aggregated gaze data were generated. The heat maps illustrate the cumulative fixations counts of all participants for benchmarks and buzzwords apps (i.e., absolute fixation count, see Figure 16), as well as the cumulative fixations durations of all participants for benchmarks and buzzwords apps (i.e., absolute fixation duration, see Figure 17). The color red in the heat-map spectrum illustrates how participants have looked at the text descriptions more than images to gather information and determines that text descriptions are their most preferred areas in the stimuli.

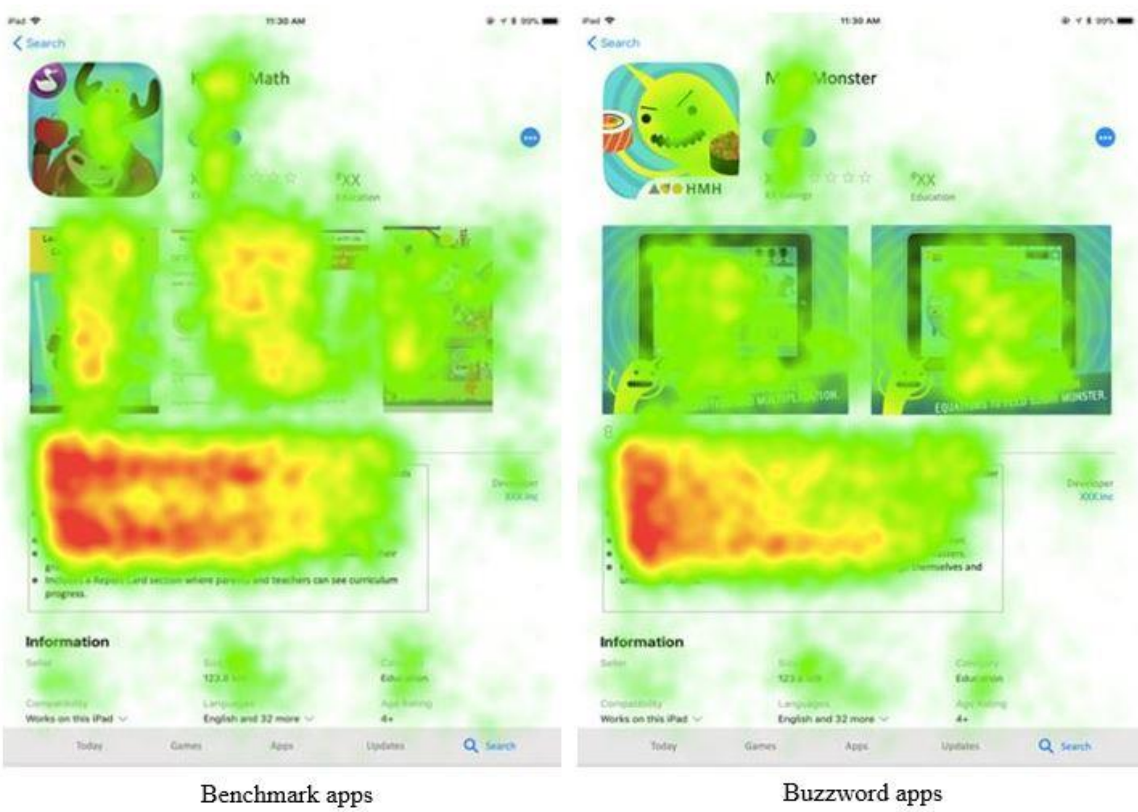

Figure 16. Absolute fixation count heat maps

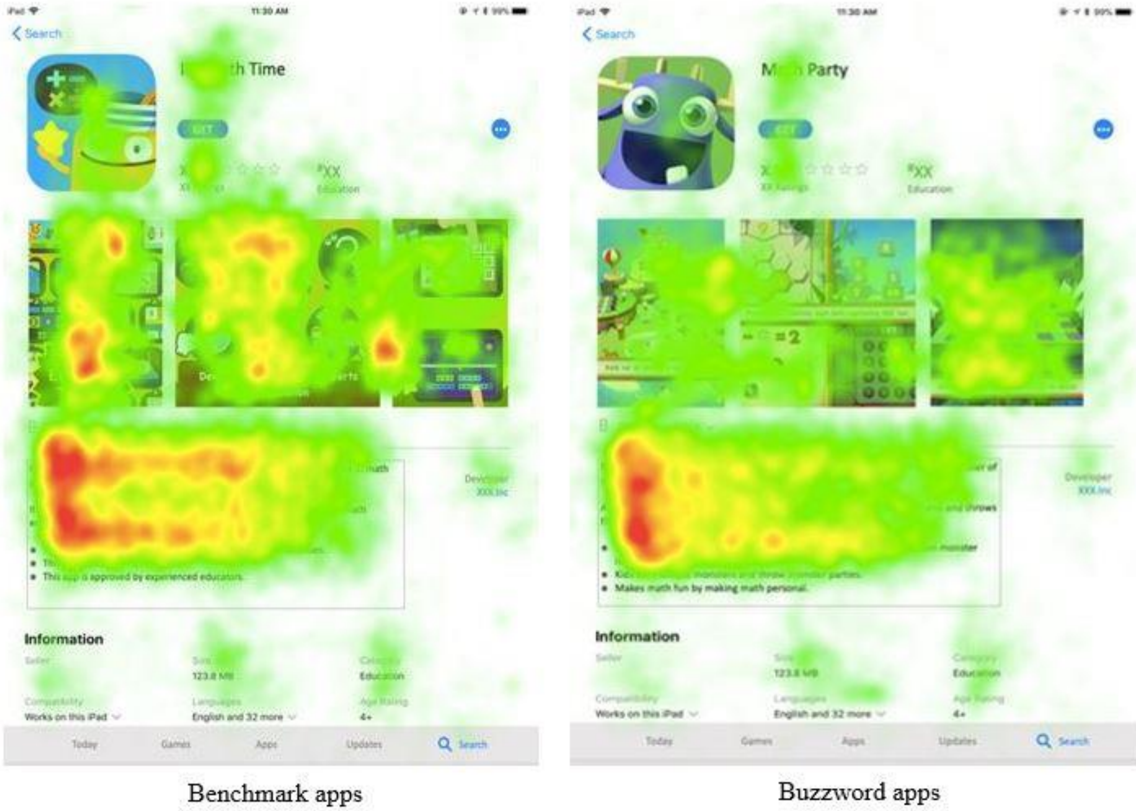

Figure 17. Absolute fixation duration heat maps

Discussion

The primary goal of the study was to determine the extent of educators' technological knowledge (TK) by investigating their app selection behavior. For successful integration of educational apps into teaching, educators need to have adequate level of TK for educational apps (Cherner et al., 2014; Mishra & Koehler, 2008). This TK is not only focused on the integration and utilization of educational apps in classrooms, but rather an in-depth knowledge of their purposes, functions, and potential outcomes, which are signified by the educational benchmarks (Cherner et al., 2014). Having educators evaluate apps with and without the five educational benchmarks, thus, provides insights into educators' app selection behavior and their level of TK. Knowledge of educational apps and their signifiers of quality are going to be critical for the successful evaluation, selection, and integration of quality apps into classrooms.

The results of the study indicate that educators have a relatively high level of TK for educational apps. Overall, the results suggest that educators are likely to select apps containing educational benchmarks over ones featuring buzzwords. Indeed, educators are more willing to download them, prefer to pay more for these apps, rate them higher, rank them above buzzword apps, and even cite the educational benchmarks more frequently than buzzword as reasons why they would download an app. Interpreting these results as evidence of high levels of TK is based on the central assumption that the choices educators made when evaluating the apps are influenced by their level of technological knowledge (Anderson et al., 2017; Blackwell et al., 2016). For example, Anderson et al. (2017) argue that educators make in-the-moment decisions when selecting educational apps using various dimensions of TPACK and particularly TK to make the best possible selection that is most likely to promote student success. This interpretation is also supported by prior research showing that educators choose technologies based on the perceived pedagogical value of a technology (Blackwell et al., 2013; 2016). This perceived value is generated by educators activating their TK for apps and using it to make distinctions between the benchmark and buzzword apps.

Overall, educators judged all five educational benchmarks as vital components in a quality educational app. However, they consider some as being more essential. Results comparing how much educators valued each educational benchmark individually indicated that they are valuing apps that feature development team, scaffolding, and curriculum benchmarks more than those with learning theory and feedback. Due to the lack of any industry standards for how to evaluate educational apps (Shuler, 2012; Papadakis & Kalogiannakis, 2017), educators consult blogs and online lists of expert-approved educational apps to use in their classrooms (Cherner et al., 2014). Therefore, the development team benchmark being valued highly makes sense as it provides educators with an assurance that the app is similarly expert-approved. Scaffolding and providing guidance play an essential role in supporting fruitful learning in educational apps (Falloon, 2013; Zydney & Warner, 2016). As such, the scaffolding benchmark being valued highly indicates that educators seem to agree that successful integration of educational apps in their teaching practice is better aided by apps that provide students with technology-mediated supports (Sharma & Hannafin, 2007; Zydney & Warner, 2016). Valuing curriculum highly suggests that educators know that online (i.e., app content) and offline (i.e., lesson being taught) resources should complement one another (Walker, 2013) and thus perceive curriculum connection as a critical aspect when attempting to integrate an educational app into their teaching process. In fact, this suggests educators are aware that educational apps connected to a curriculum can provide a means to reteach, practice, and extend classroom learning (Walker, 2013).

Educators did not value all the benchmarks as highly. Feedback is a major aspect of the learning process (Callaghan & Reich, 2018; Tärning, 2018) and a combination of different types of feedback is key to positive learning outcomes (Callaghan & Reich, 2018; Cayton-Hodges et al., 2015). However, educators valued this benchmark relatively less than the others. This might be driven from the fact that the majority of feedback embedded in educational apps are evaluative rather than informative (e.g., status or verification feedback, encouraging feedback, result feedback, Tärning, 2018). Feedback is most effective if it includes guidance and information on how to improve (Cayton-Hodges et al., 2015; Kluger & DeNisi, 1996; Petty, 2009). Thus, educators may have a low opinion of the quality of feedback the typical app provides due to their experience with the ‘typical’ educational app. The low value placed on the learning theory benchmark is somewhat in line with relatively low level of importance ‘theory’ plays in the discourse of educational apps. Learning theory is often ignored by researchers, app developers, and game designers who have been shown to not clearly identify the learning theory used in their educational app designs (Dubé et al. 2019; 2020; Kebritchi & Hirumi, 2008). As such, educators recognize learning theory as a signifier of quality educational app but value it less than the other benchmarks, just like everyone else. However, valuing apps based on an underlying theoretical foundation will ensure them that apps are designed with learning as their main purpose and will improve achievement outcomes (Dubé et al., 2019).

The eye tracking data provided further insights into educators' app selection behaviour. The main goal of including eye tracking was to determine from where educators gather information about an educational app (i.e., images or text descriptions). Prior research suggested that icon appearance influences the download behavior of users (Wang & Li, 2017). Accordingly, many developers rely on aesthetics of app images to attract users rather than relying on textual descriptions (Dubé et al., 2020). The results from the present study suggest that educators show greater interest in text descriptions (Jacob & Karn, 2003; Sharafi et al., 2015a) and spend more time analyzing and interpreting the content of the text descriptions (Sharafi et al., 2015a) than that of images. Evidently, educators spend significantly more time reading and interpreting the provided text descriptions than developers assume. Yet, educators spend more time looking at images featuring educational benchmarks than buzzwords. As suggested by Johannesson (2005), people tend to look at regions where there are identifiable and familiar features. This suggests that the educational benchmarks located within images may attract educators' visual attention as they are more noticeable and important to educators than buzzwords (McEwen & Dubé, 2015; Poole et al., 2005).

To summarize, findings of the study indicate that educational benchmarks are valued more than buzzwords with some being valued more than others. Valuing apps containing benchmarks suggests that educators are activating their TK for educational apps when selecting apps from the app store (Blackwell et al., 2016). Their level of TK enables them to identify and select apps that are most likely to benefit their students in productive and meaningful ways. Moreover, eye tracking results revealed text descriptions as being viewed more frequently than images which is contrary to previous research on app selection in which images are believed to drive decisions and dominate the app selection process. However, images of educational benchmarks apps are looked at longer which could indicate that the presence of the educational benchmarks could attract educators' attention and raise their tendency to look at these areas. Accordingly, app developers need to be sensitive to all these concerns when developing new educational apps (see conclusion).

Study 2: Parent Study

The parent study was similar to the educator study in design and measures but was conducted online and without eye tracking. The parent study was guided by the following research questions:

RQ1: Do apps featuring educational benchmarks fulfill parental needs (i.e., valuing benchmarks over buzzwords more)?

RQ2: If parents are valuing educational benchmarks, which ones do they value more?

Method

Participants

Participants consisted of 180 English-speaking parents/guardians of children between 4-11 year of age from across North America. Prior to data collection, ethics approval was obtained from the McGill Research Ethics Board. Participants were recruited via social media accounts operated by the research team including Facebook, Twitter, and Reddit as well as local parenting and library websites. For each social media account, a survey link along with a statement detailing the purpose of the study and requirements for participation (See Appendix E) was distributed. A link to the survey was also sent via the Prolific participant recruitment platform to a randomly selected sample of 150 English-speaking parents living in North America whose children were in the study's targeted age range. Data collection took place during the Fall 2019 and Winter 2020 academic semesters. During this time period, 323 responses had been recorded, of which 180 were complete and could be analyzed further. The 180 participants included in the analysis were those that completed both the demographic measures (i.e., gender, age, education level, yearly household income, ethnicity, nationality, number of children, as well as each child's age, gender, and grade) and other study measures. Consent was obtained via a digital consent form immediately prior to study participation (See Appendix F). All participants were entered into a one-time draw for $50 CAD iTunes or android app store gift card as compensation for participating in the study.

Participants were primarily female (57.2%) with a mean age of 37.09 years (*SD* = 6.11). Most participants indicated "Bachelor/ trade/ technical degree" (44.4%) as their highest level of education, which was followed by "High school degree or equivalent" (21.1%) and "Graduate degree" (20.6%). Regarding their yearly household income, majority of participants were among these three groups, "$75,000 to $99.999" (23.3%), "$50,000 to $74.999" (21.7%) and "$100,000 to $149.999" (21.7%). Participants' ethnicities were predominantly White (74.4%); the two other ethnicities with higher frequencies were Hispanic or Latino (7.2%) and Asian or Pacific Islander (5.6%). Participants' two main nationalities were American (63.3%) and Canadian (20%).

Procedure, Materials, and Measures

The study was designed and administered using Survey Monkey. The highest security level available with encryption services on Survey Monkey were used to ensure confidentiality and the security of responses. Parents from across North America completed the survey online. The procedure was almost identical to the Educator study, with two differences. First, this study did not include any eye tracking related procedures (calibrating), materials (computers, eye tracker), and measures (fixation count, fixation duration, heat maps). Second, the order of the math apps was randomized (cf., counterbalanced in study 1) to account for order effects. The eye tracking software used in study 1 did not allow for true randomization whereas the SurveyMonkey platform used in study 2 did allow for true randomization of the math apps.

Results

RQ1: Do apps featuring educational benchmarks fulfill parental needs (i.e., valuing benchmarks or buzzwords more)?

Paired sample *t*-test were conducted to identify whether parents are valuing benchmarks or buzzwords. Four paired sample *t*-test were conducted on the average of the four measures of download, cost, rate, and rank. To compare benchmarks and buzzwords, the average for each value judgements were calculated for all the benchmarks combined and all the buzzwords combined.

Parents were more likely to download apps containing educational benchmarks (M = 63.66%, SD = 24.60) than buzzwords (M = 57.33%, SD = 24.41), $t(179) = 2.60$, $p = .010$. They were willing to pay more for benchmark apps (M = \$2.23, SD = 3.25) than buzzword apps (M = \$1.78, SD = 3.16), $t(179) = 3.58$, $p = .000$. Parents rated benchmark apps (M = 3.32, SD = .67) higher than buzzword apps (M = 3.08, SD = .67), $t(179) = 4.67$, $p = .000$. However, parents ranked apps containing buzzwords (*M* = 5.59, *SD* = .93) no different than those containing benchmarks (*M* = 5.40, *SD* = .93), *t*(174) = -1.38, *p* = .167. Overall, parents valued benchmark apps over buzzword apps, except when ranking them.

Using a digital text-mining tool, a text analysis was conducted on educators' responses to the question "what reason do you have for downloading this app or not". Specifically, the relative frequency with which educators spontaneously mentioned the benchmarks and buzzwords in their answer was compared between benchmark and buzzword apps (see Figure 18 & 19). A visual analysis of the relative frequency reveals that revealed that overall, parents cited educational benchmarks more than buzzwords. Further analysis demonstrated that parents cited feedback and experts (i.e., development team) as the first and second most frequent word among educational benchmarks, while interactive and engaging were the most frequently cited buzzwords. Interestingly, parents cited the engaging buzzword as frequently as the feedback benchmark in their reasons for downloading benchmark apps. No benchmark app was cited with such relative frequency for buzzword apps.

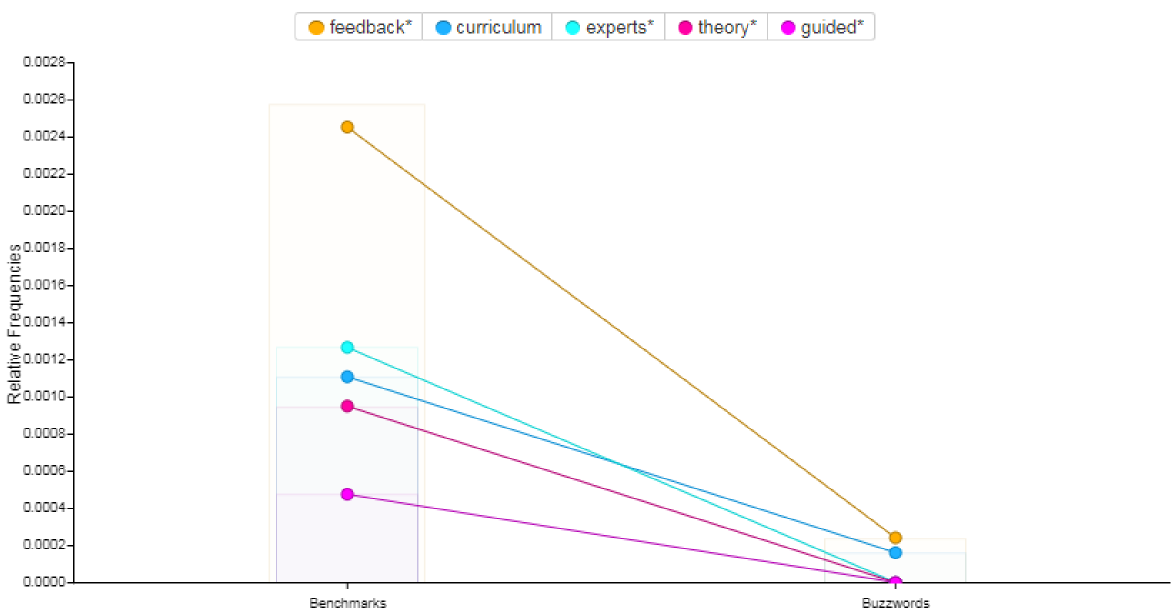

Figure 18. Parents' graph of word frequency of educational benchmarks*

*Note. The term ‘guided’ was used by parents as an alternative to ‘scaffold’

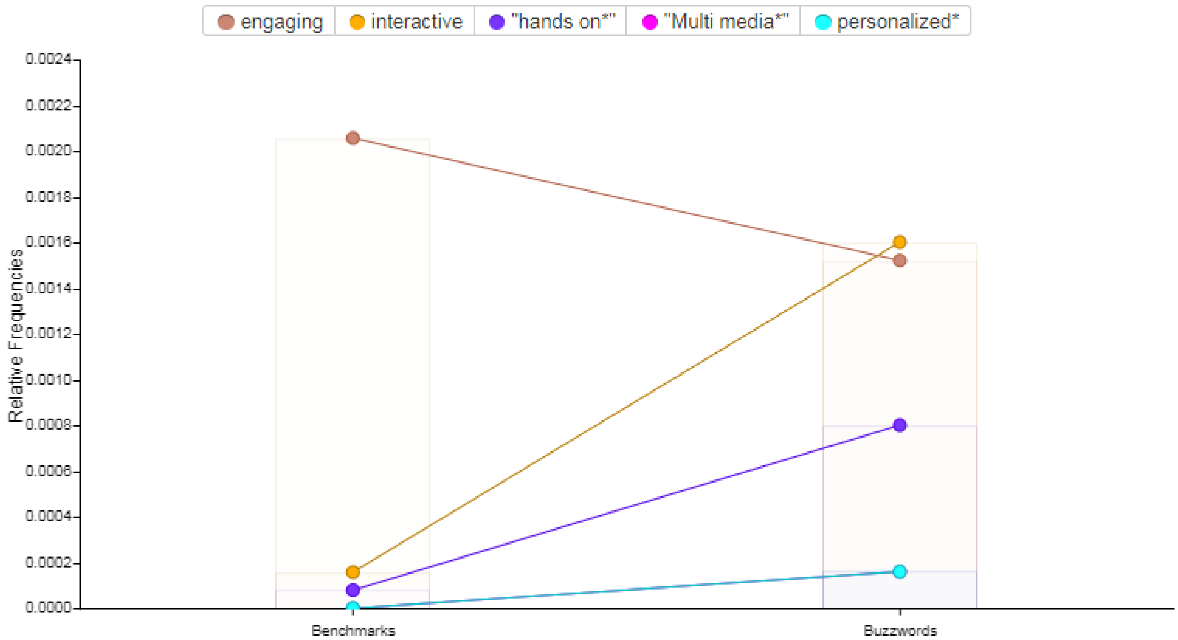

Figure 19. Parents’ graph of word frequency of buzzwords

RQ2: If parents are valuing educational benchmarks, which ones are they valuing more?

Based on the results of research question one, it was determined that parents mostly valued apps containing educational benchmarks over those containing buzzwords and that they spontaneously cited some benchmarks more than others. To further investigate which of the five benchmarks were valued more, repeated-measures within-subjects ANOVAs were conducted on all four value judgements measures.

Parents were willing to download some benchmark apps more than others, $F(3.78, 676.56) = 6.29$, $MSE = .22$, $p = .000$. Parents were less likely to download the learning theory app than the scaffolding ($p = .003$), curriculum ($p = .007$), development team ($p = .000$) and feedback ($p = .003$) apps. Overall, the development team benchmark had the highest download frequency while learning theory had the lowest download frequency among all the benchmarks (see Figure 20).

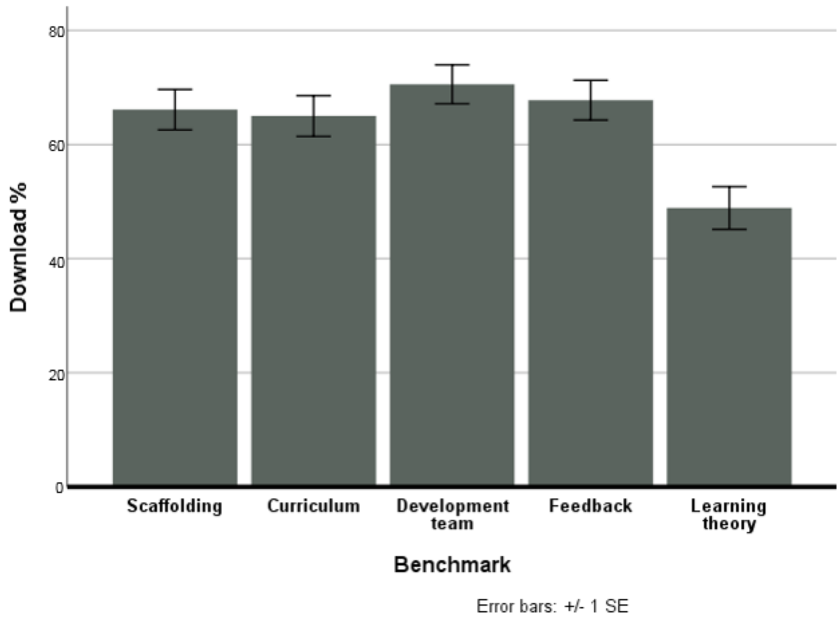

Figure 20. Differences among the five benchmarks for “Download” measure (Study 2)

The amount parents were willing to pay did not differ among the benchmark apps, *F*(3.20, 574.33) = 1.75, *MSE* = 8.06, *p* = .150. However, the pairwise comparisons did indicate that parents are willing to pay more for the development team app than ones containing feedback (*p* = .003, see Figure 21).

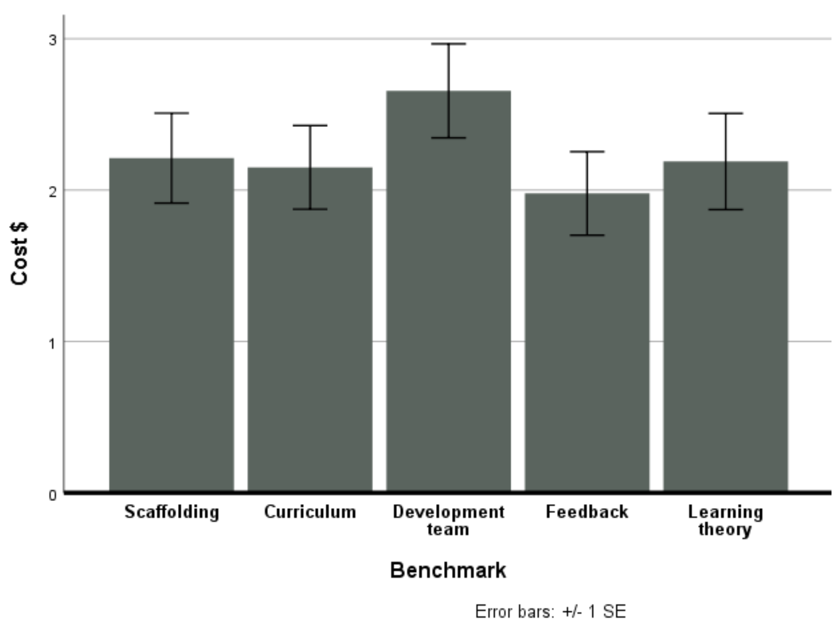

Figure 21. Differences among the five benchmarks for “Cost” measure (Study 2)

Parents also rated the apps differently depending on benchmarks, $F(4, 716) = 6.25$, $MSE = .88$, $p = .000$. Specifically, the learning theory app was rated lower than the scaffolding ($p = .032$) and development team ($p = .000$) apps. Overall, parents rated development team the highest and learning theory the lowest (see Figure 22).

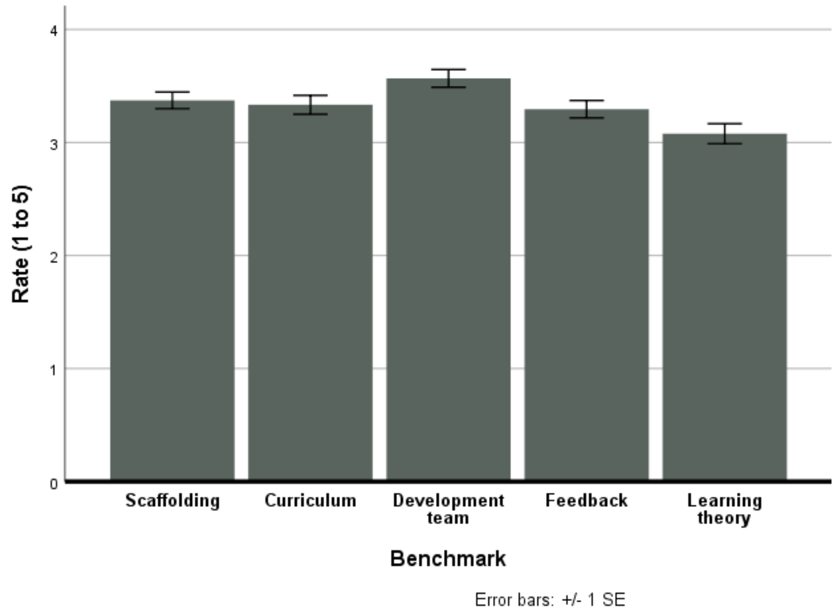

Figure 22. Differences among the five benchmarks for "Rate" measure (Study 2)

Parents' rankings also differed among benchmark apps, $F(3.71, 646.82) = 3.67$, $MSE = 9.36$, $p = .007$. The learning theory app was, somewhat surprisingly, ranked higher than development team app ($p = .047$). In fact, the learning theory app was ranked the highest of all the benchmark apps while the development team app received the lowest ranking from parents (see Figure 23).

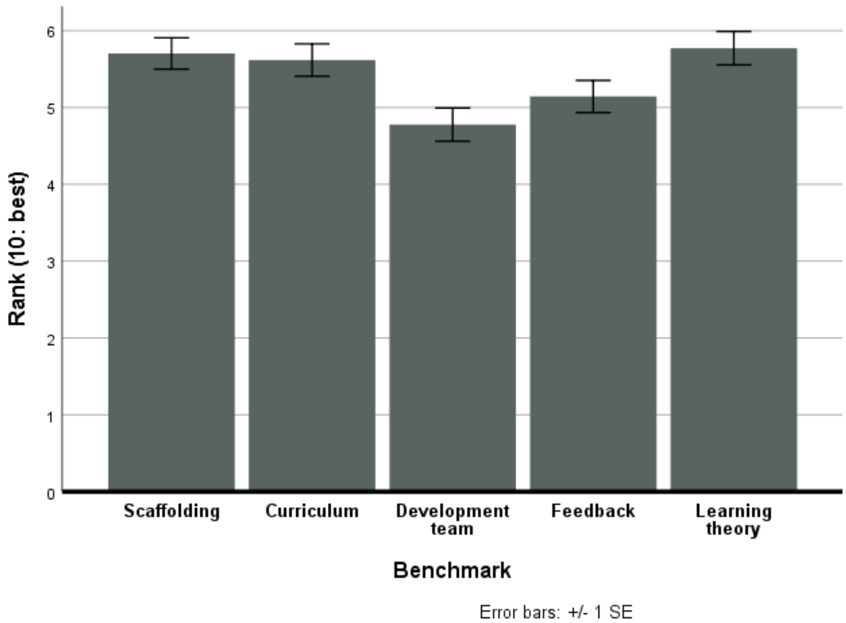

Figure 23. Differences among the five benchmarks for "Rank" measure (Study 2)

Discussion

Uses and Gratification theory offers a potential framework for explaining medium-specific needs in new media platforms (Broekman et al., 2016). As such, U&G theory holds that parents select educational apps to fulfill certain needs (Broekman et al., 2016; 2018). This study attempted to look at the extent to which research-based educational benchmarks satisfy parental needs for educational apps. Thus, we gained a better understanding of parental needs associated with educational apps.

Findings indicate that parents are valuing educational benchmarks over buzzwords. In fact, they would be more willing to download them, prefer to pay more for these apps, rate them higher, and even cite the educational benchmarks more frequently than buzzword as reasons why they would download an app. Like educators, parents are valuing some benchmarks more than others. In particular, parents value apps that are created by an interdisciplinary team of educational experts (Vaala et al., 2015) more than any other benchmark. This need might have been fostered by parenting websites (e.g., Common Sense Media and Children's Technology Review). As they aim to inform parents about different quality apps based on expert reviews (Dubé et al., 2020; Hirsh-Pasek et al., 2015; Shuler et al., 2012; Vaala et al., 2015) and often emphasize the importance of expert opinions in app selection. Interestingly, one can argue that the development team benchmark has both parent-centered and child-centered dimensions. As these types of apps are aligned with the learner's developmental needs and abilities (Callaghan & Reich, 2018) and thus engage children effectively with learning-centered quality content (Dubé et al., 2019).

Scaffolding, curriculum and feedback were the other educational benchmarks that seem to satisfy the parents' needs, while learning theory was the least likely benchmark to do so. Scaffolding provides children with support and assists them in accomplishing tasks that are beyond their capability and cannot be carried out independently (Hirsh-Pasek et al., 2015; Tabak & Kyza, 2018; Wood et al., 1976). Therefore, parents' need for scaffolded learning may come from the notion that parents usually look for apps that are self-guided so their child would be able to independently use the app without parental support (Broekman et al., 2016). Containing a guiding curriculum also seemed to meet parental needs for educational apps. In fact, parents generally think of curriculum as a signifier of educational quality and react to the presence or absence of this benchmark while making many education related decisions (Vaala et al., 2015). Typically, 'rewards' are often considered as one of the most gratifying app features for parents (Broekman et al., 2018), who refer to rewards as central child-centered need (Broekman et al., 2016). The feedback benchmark is also valued by parents and may satisfy parental needs as it serves the same function as rewards in educational apps, but with more formative guidance (Tärning, 2018). For these parents, learning theory is the least gratifying feature among all educational benchmarks. This might occur because this benchmark is the most underrepresented in app stores (Dubé et al., 2020) and refers to the higher-level pedagogical approach and instructional strategies of an app (Kebritchi & Hirumi, 2008), which makes it a rather abstract concept for parents. However, having a clear design is one app feature commonly emphasized by parents (Broekman et al., 2018). Perhaps conveying the importance of learning theories to parents could be achieved by linking this benchmark to parents' pre-existing preference for clear app design.

Overall, parents are often looking for content that can provide educational benefits to their children (Broekman et al., 2016). Therefore, valuing educational benchmarks over buzzwords suggests that parents are primarily seeking apps that meet their children's educational needs, not only because they believe such features are important, but also because they feel that their children will benefit from them and will react in a positive way to such apps. Indeed, parents are identifying and valuing research supported features when looking for educational apps to address their dual-purpose needs (i.e., parent-centered and child-centered).

Limitations and Future Directions

The lack of research exploring educational app selection and the existing limitations in these current studies provide direction for future research. The 10 simulated math applications were crafted according to app store descriptions but altered to include the educational benchmarks and buzzwords. Future research could be conducted to study whether educators and parents are able to spot the educational benchmarks in the text descriptions and images of real apps in the App Store or not. Moreover, results of the eye tracking study indicated that overall educators spent more time on apps' text descriptions than images which contradicts with the prior studies in this area. Future research could be done to study the features in the app images that attract the highest level of attention so that developers could work on optimizing those features. In addition, participants in the educator's study were limited to working and pre-service teachers. Considering the higher number of pre-service teachers, a comparison between TK levels of these two groups was not possible (i.e., the extent of an individual's TK level may vary depending upon years of experience). Therefore, future research should investigate the differing levels of TK between these two groups. Similarly, the present study did not investigate individual differences in parents' educational app needs. For example, parental needs may vary based on different parenting style (e.g., authoritative, authoritarian, and permissive parenting, Broekman et al., 2016). Parents with an authoritarian parenting style may have more parent-centered needs and goals as oppose to authoritative parents with higher child-centered needs and goals (Broekman et al., 2016). Future research could investigate individual differences in parental needs, differences among parenting styles being one possible factor.

Conclusion

Technology use is not as simple as it might seem. Different technologies have their own potentials, features, uses, and constraints that make them more suitable for certain tasks in comparison to others (Mishra & Koehler, 2008). Therefore, how the features and constraints of a particular technology influence educators' work in the classrooms and parental digital learning tools use in the home is not simple and easy to understand and may require rethinking teacher education (Koehler & Mishra, 2009) and parental guidance. For educators, the importance of technological knowledge (TK) is paramount in light of the increasing use and popularity of educational apps (Cherner et al., 2014; Tärning, 2018). It is the job of educators to creatively apply these educational apps to their teaching practice and meet the instructional needs of their students in innovative ways. Therefore, educators need to acquire the required technological knowledge to effectively evaluate, select, and use quality apps in their teaching. Considering educators’ lower level of TK for some of the educational benchmarks, it is suggested that working and pre-service teachers be provided with training programs and development on educational apps. This would help ensure they are equipped with adequate knowledge for making informed decisions while selecting and integrating apps into their teaching practices. For parents, it is important that their educational app needs are aligned and support their children’s need for quality educational apps. This alignment is largely present but effort should be made to help parents grasp the more abstract benchmarks.

Both educators and parents value educational benchmarks and this makes an even stronger case for why they should be included in more educational apps and clearly identified in app stores. If developers include these benchmarks in their apps and app store descriptions, then not only will this provide a research-based framework for developing and identifying a quality app but it will result in developers creating apps already sought by educators and parents. These benchmarks could even be used to determine a set of evidence-based guidelines to assist regulatory authorities and app developers in the process of presenting and advertising apps, which would help the educational system to more effectively identify and select quality educational apps. In the end, educators and parents are the primary purchasers of educational apps and they demonstrate clear opinions on the types of educational apps they want. Hopefully, industry will be prompted to create and surface better educational apps based on this clear picture of what drives educator and parent app selection decisions.

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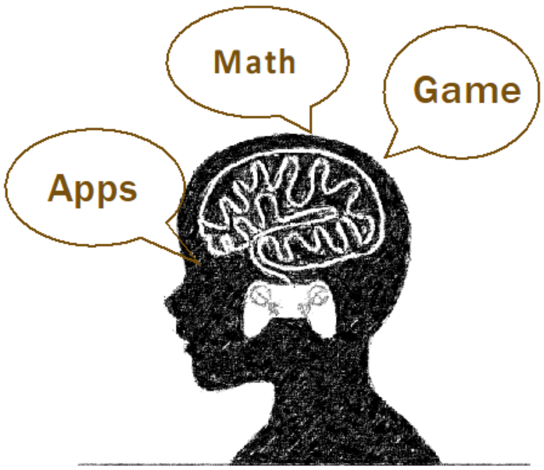
Appendix A

Study 1 Poster

Participants Needed for a Study on Educational Games

TLC | McGill UNIVERSITY



Are you interested in educational Apps?

Have you ever wondered which Apps are better ?

We are conducting a study on how educators choose Math Apps for their students and we need current and future math educators to participate.

We need your help!!!!

We invite you to participate in this study,

If your answer **YES** to **following** question:

✓Are you a current or future elementary mathematics teacher?

✓If you are interested in participating or have more questions, please e-mail us: teklrncog@gmail.com

The study will take approximately 30 minutes at the Technology, Learning and Cognition Lab, located in the Education Building, McGill University	Participants will be offered $10 cash compensation for your time	This study is conducted under the supervision of Prof. Adam Dubé at the Department of Educational & Counselling Psychology, **adam.dube@mcgill.ca**

teklrncog@gmail.com | teklrncog@gmail.com | teklrncog@gmail.com | teklrncog@gmail.com | teklrncog@gmail.com | teklrncog@gmail.com | teklrncog@gmail.com | teklrncog@gmail.com | teklrncog@gmail.com | teklrncog@gmail.com | teklrncog@gmail.com | teklrncog@gmail.com | teklrncog@gmail.com

Appendix B

Study 1 Consent Form

McGill | Department of Educational and Counselling Psychology in the Faculty of Education | Département de psychopédagogie et de counseling de la Faculté des sciences de l'éducation

Title of Study: Why this app? How educators choose a good educational app.

Principal Investigator: Professor Adam K. Dubé
adam.dube@mcgill.ca
Assistant Professor, Learning Sciences Program
Department of Educational & Counselling Psychology
McGill University

Sponsor: McGill Internal SSHRC Development Grant

Research Team:
Armaghan Montazami, Master student
Heather Pearson, Master student

Purpose of the Study: There are over 80,000 educational apps in the iTunes app store and these apps are of varying levels of quality. Some are effective but many are not. Considering that educators often choose which apps their students use, we want to understand how educators choose educational apps (e.g., a math app for a smartphone). App Stores provide a lot of information about an app, and by completing this study you will help us determine which information educators value.

Participants: You are being asked to participate in the study because you are or are going to be an elementary mathematics educator.

Procedures: If you agree to participate in this study, you will complete a short demographic survey (e.g., age, gender). Then, you will be shown 10 different educational apps on a computer and asked questions to gauge your opinion of these apps (e.g., "Would you download it?", "How would you rate it?", "At what price would you like to download this app"). Finally, you will be asked to rank the apps from best to worst. While you complete the study, an eye tracker will be recording where you are looking. The eye tracker is a camera that uses an image of your eye to determine where you are looking on the computer screen. It cannot track your vision outside the computer screen and no identifying features will be recorded with the eye-tracker when capturing eye images during the study. We will use this information to determine which aspects of the apps informed your opinion.

The study will take approximately 30 minutes to complete and does not require any follow-up participation. The data from this survey will be coded and encrypted to ensure it remains confidential. *This study has been reviewed and approved and for ethical compliance by the McGill University Research Ethics Board.* General results will be made available to you on request.

Benefits of Participation: Possible benefits from study participation include an opportunity to reflect on how you choose educational apps.

Risks of Participation: There are no risks associated with participating in this study.

Cost /Compensation: Participants who complete the study will receive $10 in cash.

Contact Information/Questions: If you have any questions or concerns about the study, you may contact the Principle Investigator, Professor Adam K. Dubé (teklrncog@gmail.com).

If you have any ethical concerns or complaints about your participation in this study and want to speak with someone not on the research team, please contact the McGill Ethics Manager (lynda.mcneil@mcgill.ca; 514-398-6831) referencing REB #412-0319.

Voluntary Participation: Your participation in this study is voluntary. You may refuse to participate in this study and you may withdraw from the study at any time without prejudice to your relations with the university. You are encouraged to ask questions about this study at any time prior to or after the study via email.

Confidentiality: Your participation in this study is completely confidential and all questionnaire responses will be kept confidential. No reference will be made in written or oral materials that could link you to this study. All digital records will be saved in password encrypted files in a locked facility at McGill University for at least 7 years following study completion at which time it will be destroyed. In the event that data is destroyed before 7 years, participants will be informed. Access to participants' anonymized data will be limited to members of the research laboratory of Professor Adam K. Dubé.

Please sign below if you have read the above information and consent to participate in this study. Agreeing to participate in this study does not waive any of your rights or release the researchers from their responsibilities. A copy of this consent form will be given to you and the researcher will keep a copy. To ensure the study is being conducted properly, authorized individuals such as a member of the Research Ethics board, may have access to your information. By signing this consent form, you are allowing such access.

____________________________   __________________
(Participant's name: Please Print)   (date)

____
(Participant's signature)

Appendix C

Study 1 Questions

1. Please click **"yes"** below if you have read the above information and consent to participate * in this study.

Yes
No

* 2. Please enter your participant number as given by the researcher.

3. Which of the following apply to you?

Currently working teacher
Pre-service teacher

4. Which grade(s) are you currently teaching? (Check all that apply)

Grade 1
Grade 2
Grade 3
Grade 4
Grade 5
Grade 6
Not applicable

5. If you are a pre-service teacher, which grade(s) are you interested in teaching? (Check all that apply)

Grade 1
Grade 2
Grade 3
Grade 4
Grade 5
Grade 6
Not applicable

6. Approximately how many full years of experience do you have? (Not including field placements)

7. Please indicate your gender.

Female
Male
Other

8. Please state your age in years.

9. What is your ethnicity? * (Please check one)

White / Caucasian
Black or African American
Hispanic or Latino
Asian or Pacific Islander
American Indian or Alaskan Native
Prefer not to disclose.
Other (please specify)

10. Are you currently using math apps in your classroom?

Yes
No
Not applicable

11. How often do you use math apps in the classroom?

Every day
A few times a week
About once a week
A few times a month
Once a month
Less than once a month
Never
Not applicable

12. Which technology do you implement in your classroom? (Click all that apply)

Tablets
Laptops
Desktops
Cell phones
None
Not applicable
Other (please specify)

Please answer the following questions based on app 1-10.

Would you download this app?

Yes
No

Approximately how much would you be willing to pay for this app?

Free to $30

Overall, how would you rate this app?

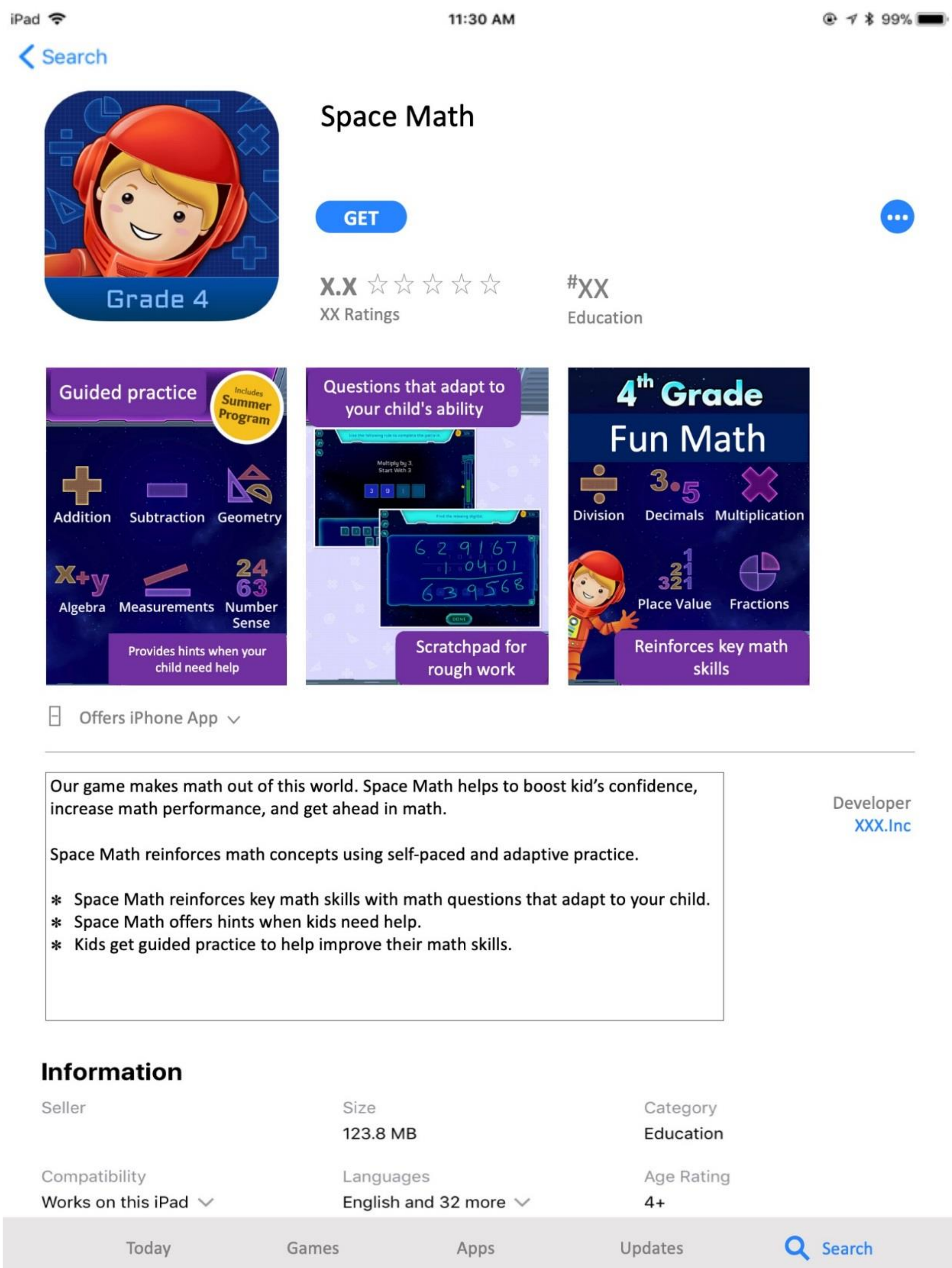
1 to 5

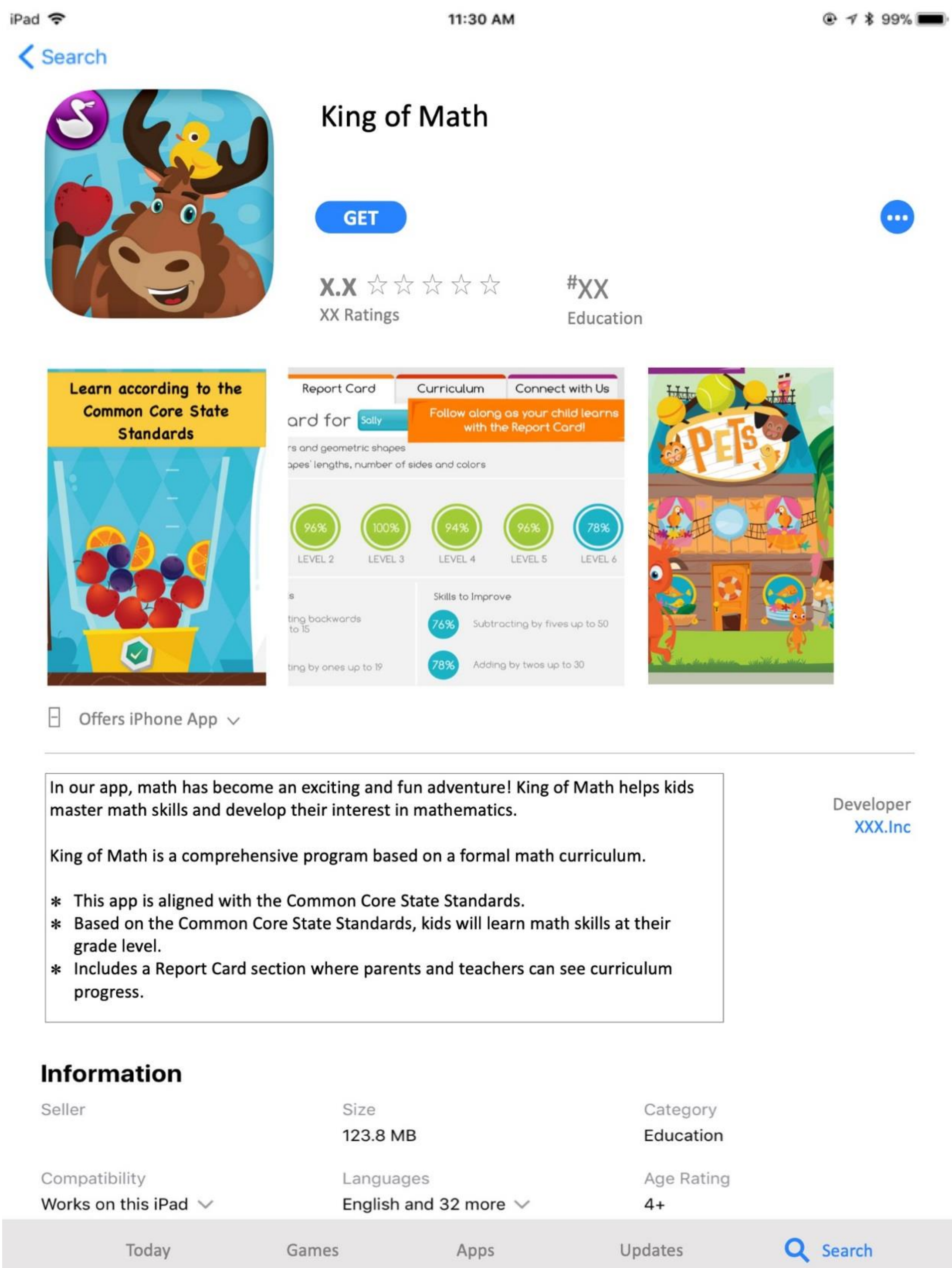
What reasons do you have for downloading this app or not?

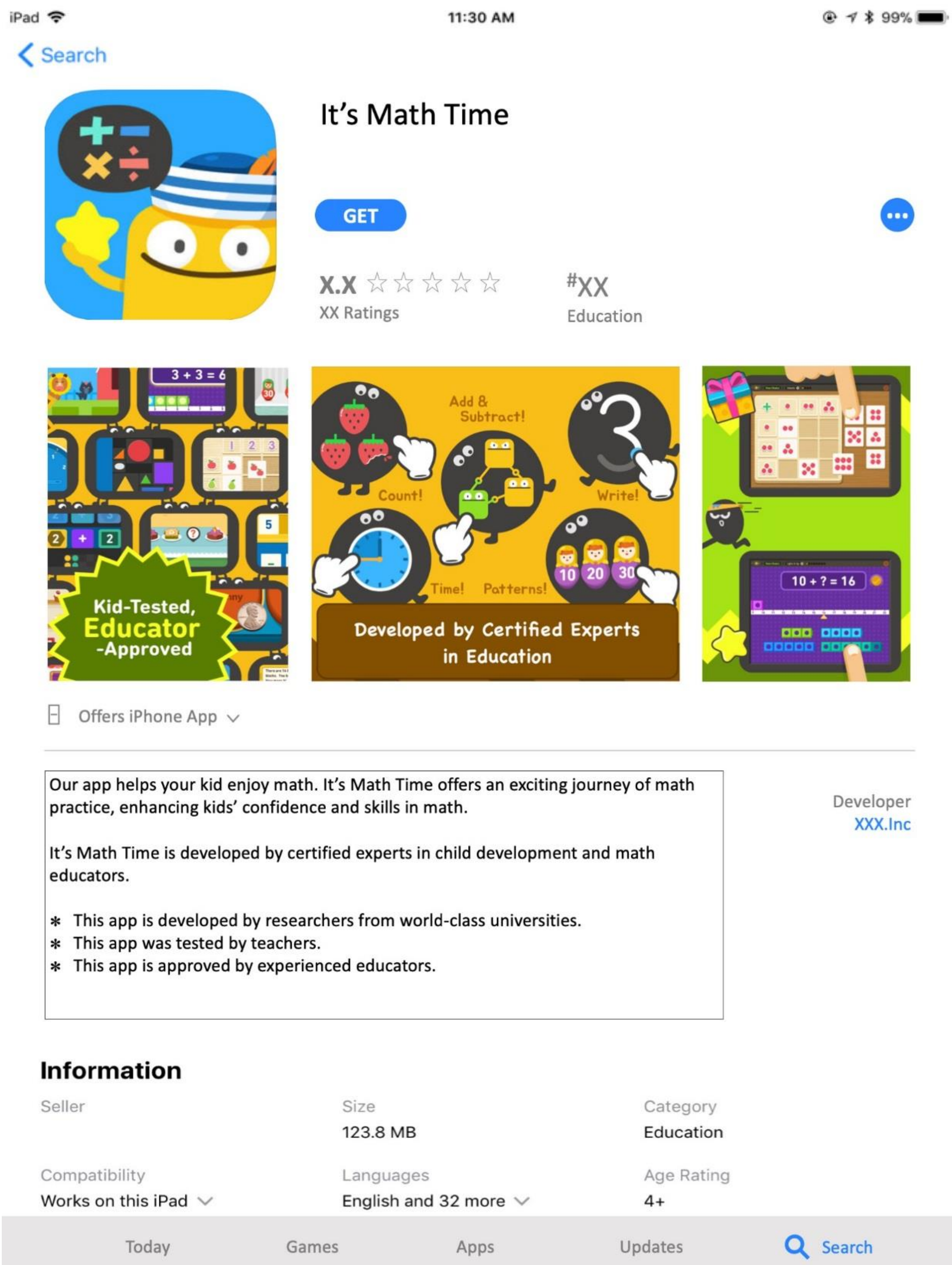
After seeing all the apps, please rank the above apps from worst to best (1 = the worst & lowest/ 10= the best & highest)

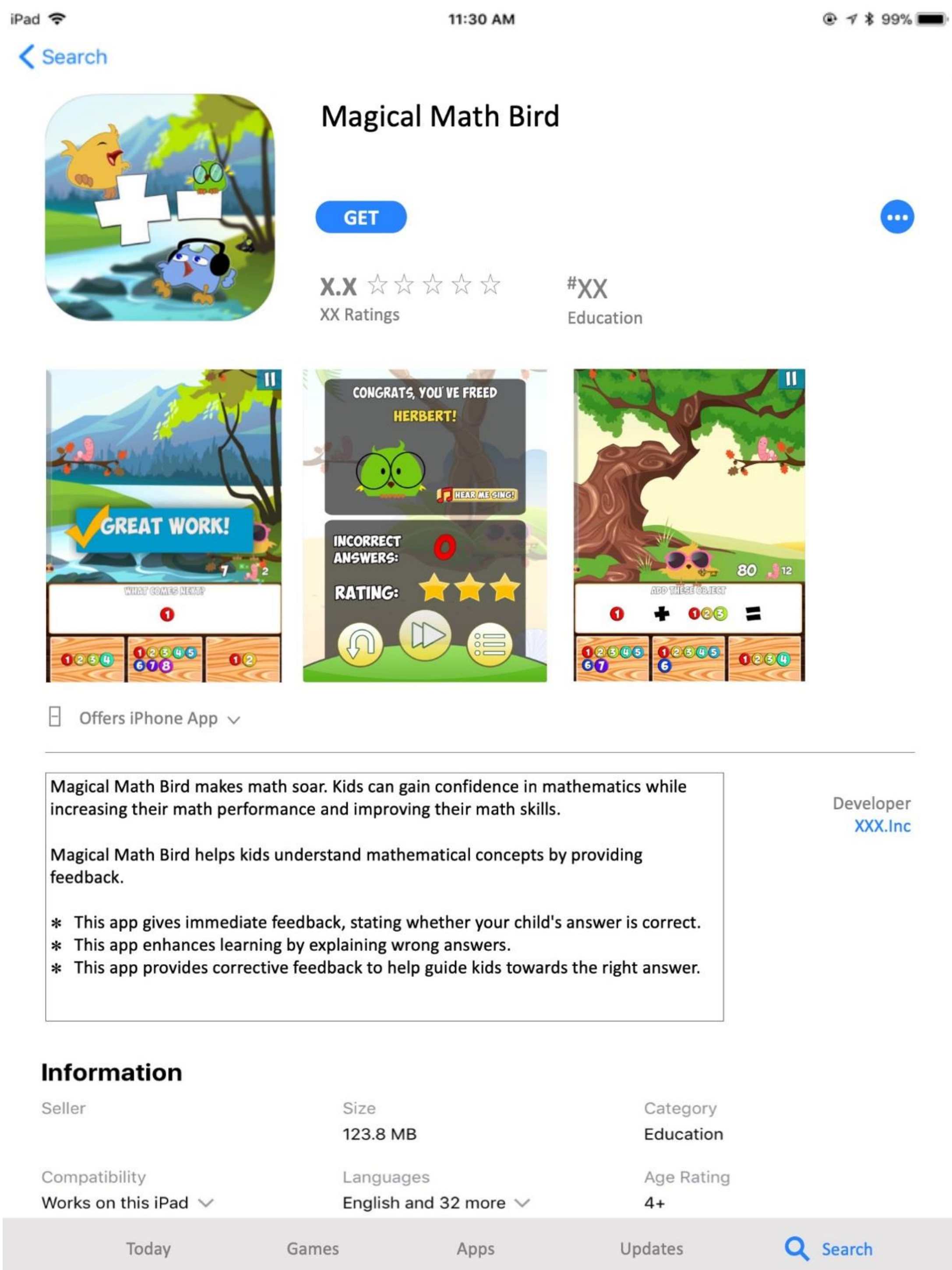
Appendix D

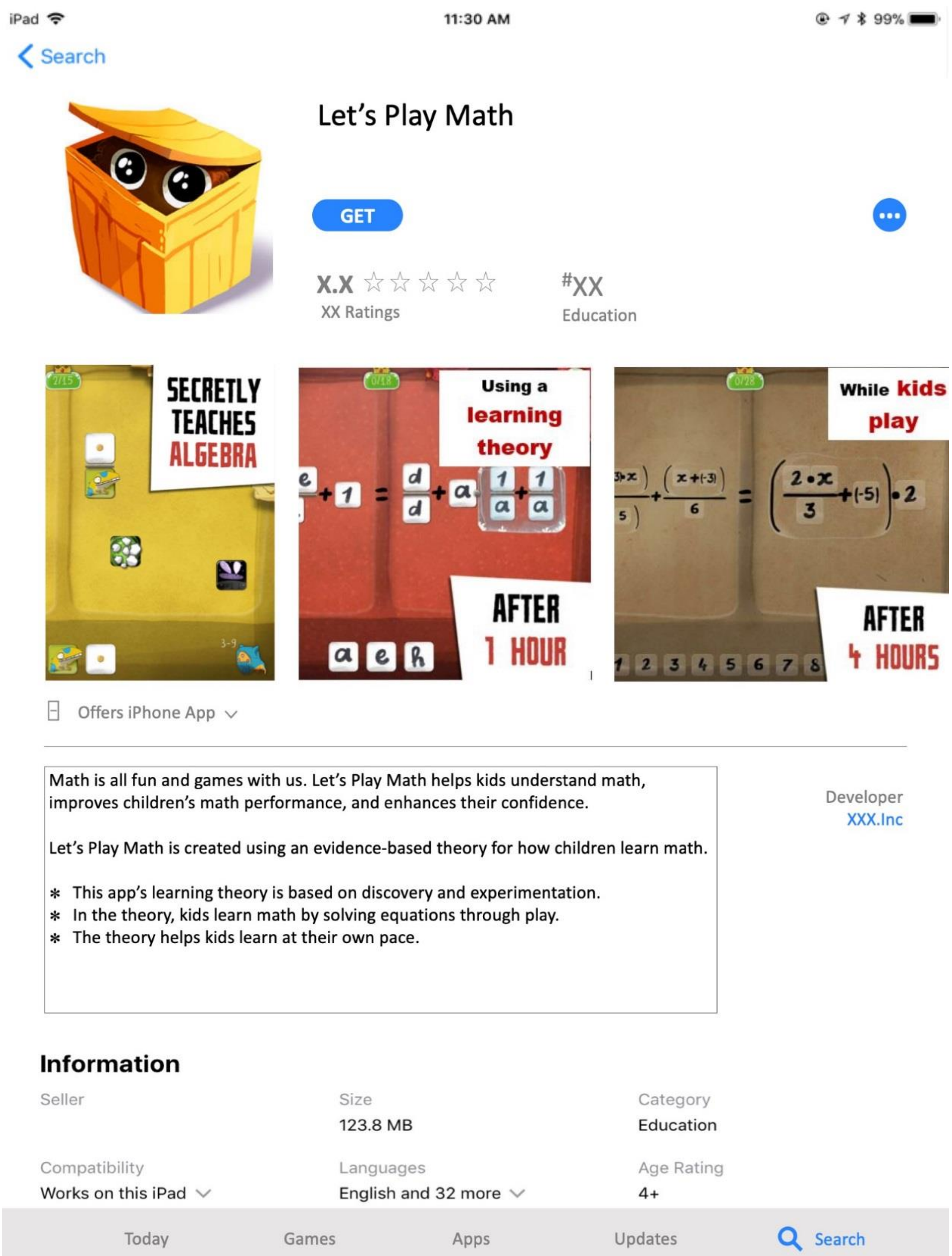
Ten Simulated Math Applications

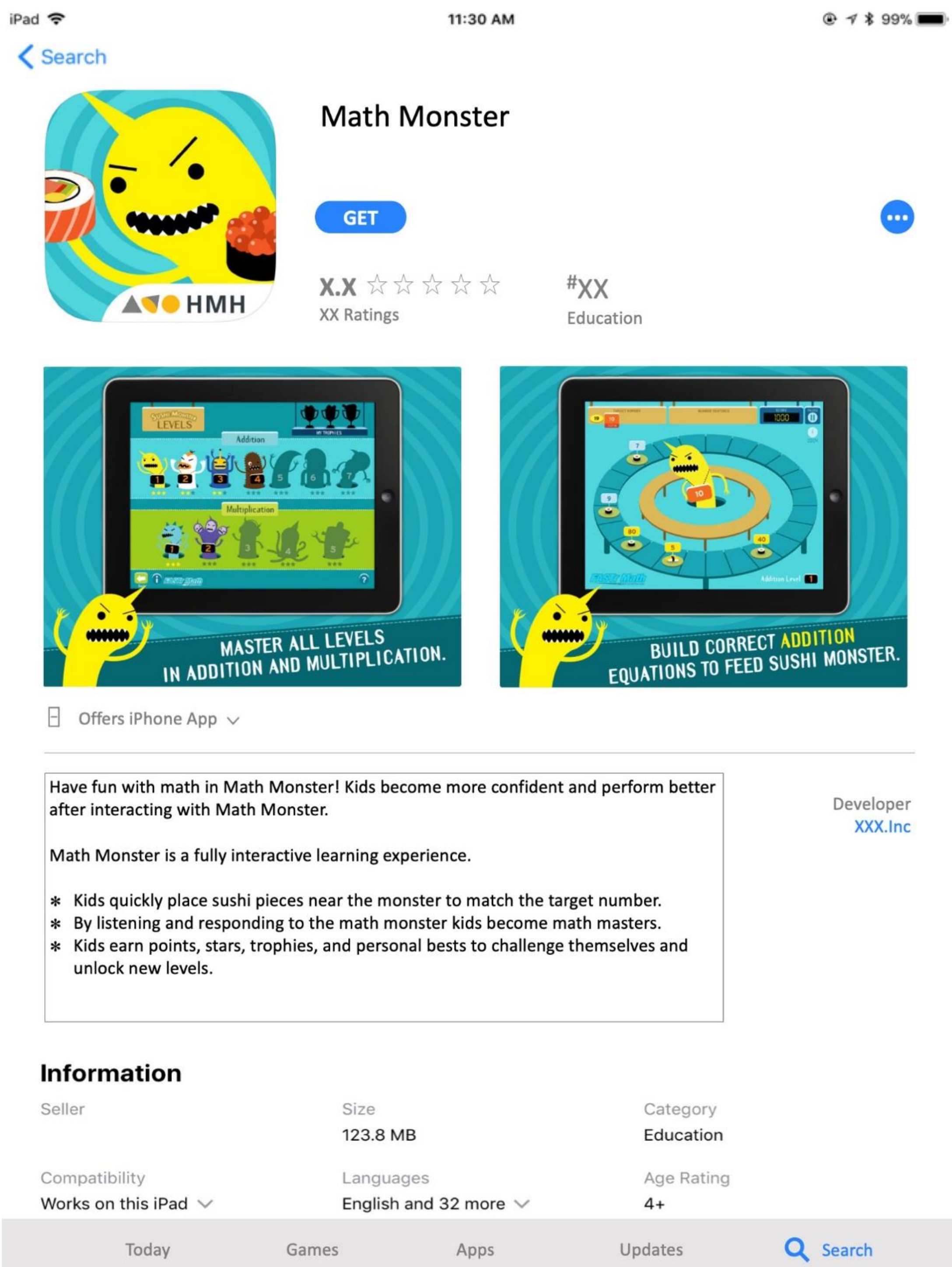


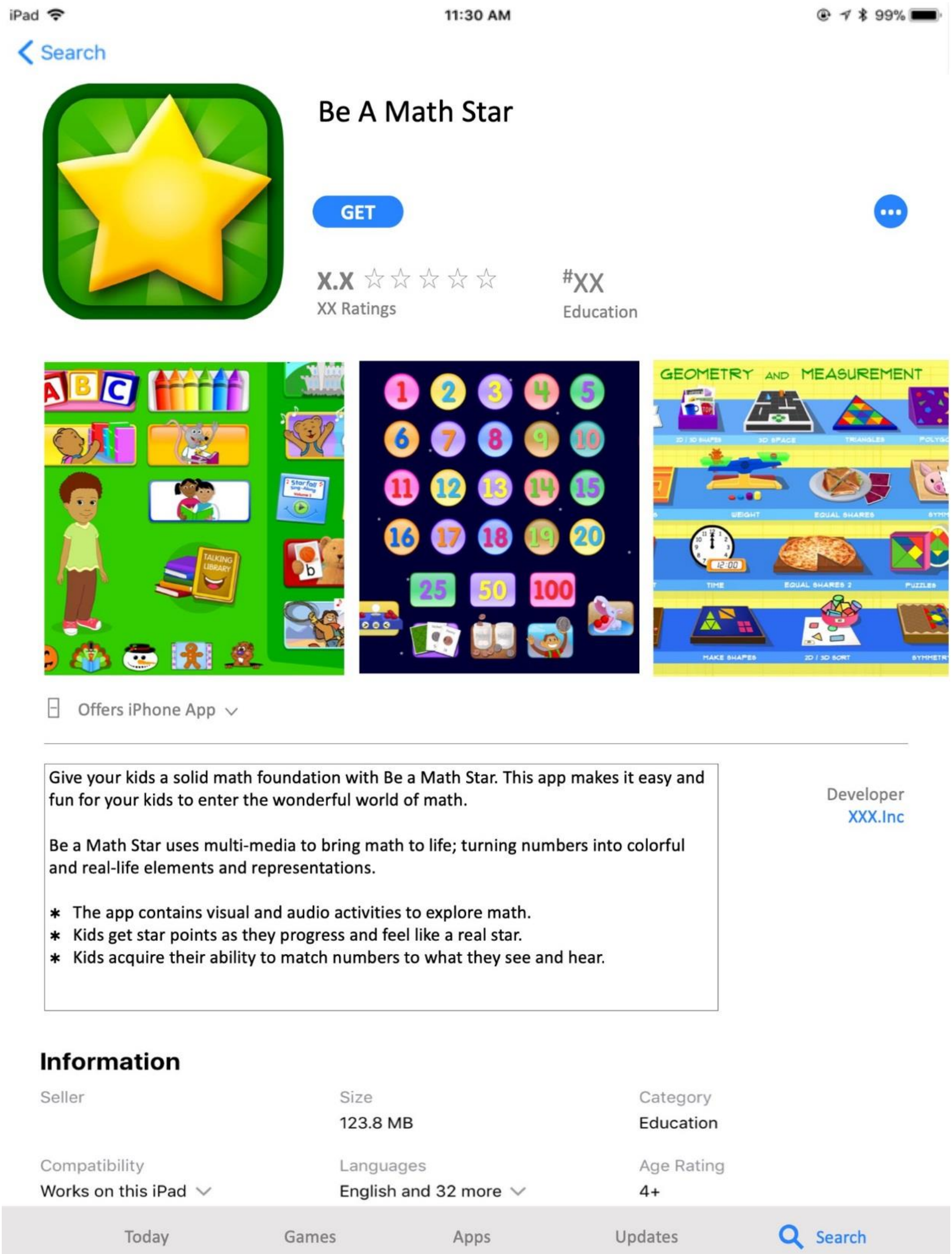

iPad
11:30 AM
99%
Search
King of Math
GET
X.X
XX Ratings
#XX
Education
Learn according to the Common Core State Standards
Report Card
Curriculum
Connect with Us
Follow along as your child learns with the Report Card!
96%
LEVEL 2
100%
LEVEL 3
94%
LEVEL 4
96%
LEVEL 5
78%
LEVEL 6
Skills to Improve
76%
Subtracting by fives up to 50
78%
Adding by twos up to 30
PETS
Offers iPhone App
In our app, math has become an exciting and fun adventure! King of Math helps kids master math skills and develop their interest in mathematics.
King of Math is a comprehensive program based on a formal math curriculum.
* This app is aligned with the Common Core State Standards.
* Based on the Common Core State Standards, kids will learn math skills at their grade level.
* Includes a Report Card section where parents and teachers can see curriculum progress.
Developer
XXX.Inc
Information
Seller
Size
123.8 MB
Category
Education
Compatibility
Works on this iPad
Languages
English and 32 more
Age Rating
4+
Today
Games
Apps
Updates
Search

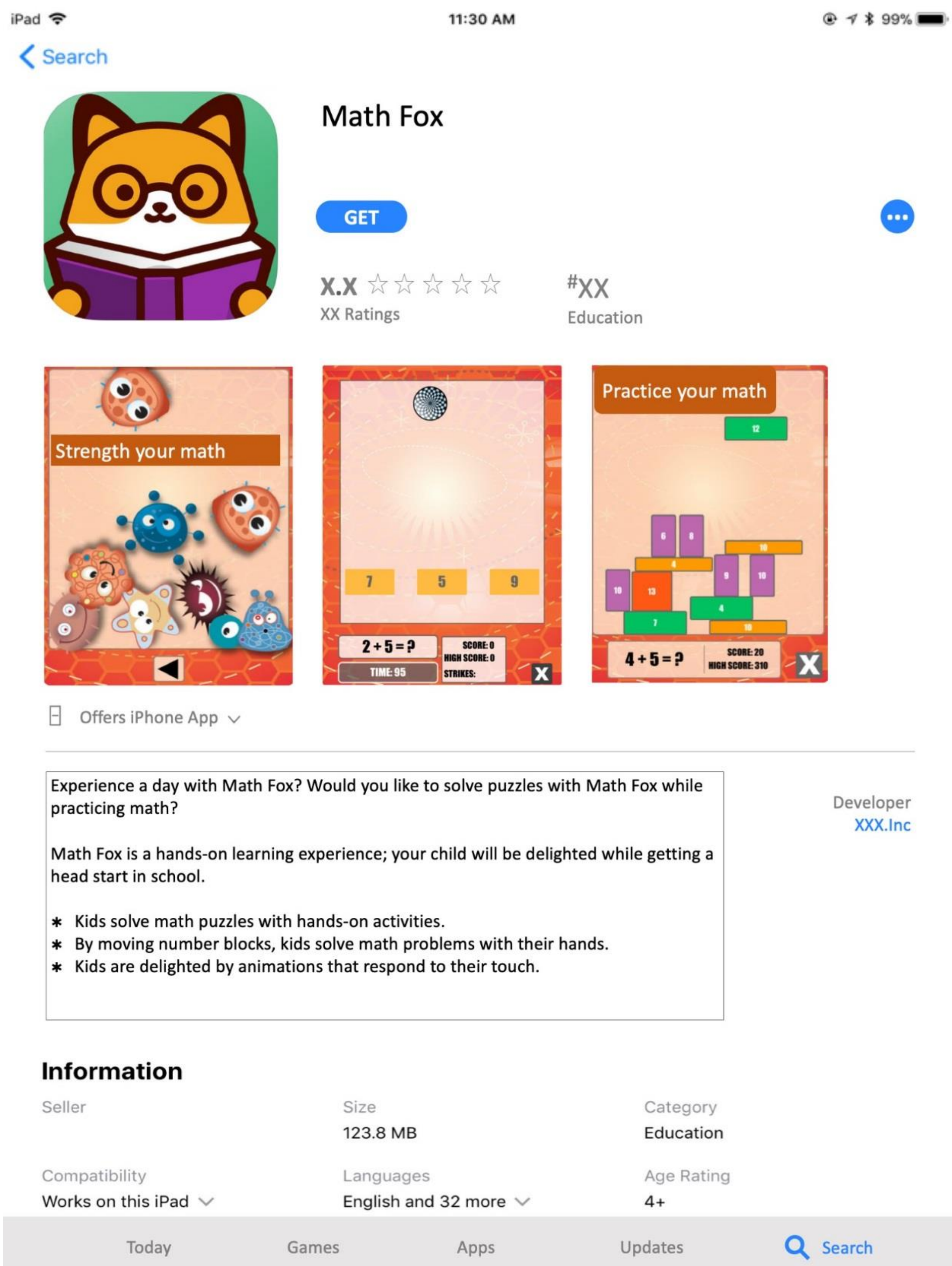

iPad
11:30 AM
99%
Search
It's Math Time
GET
X.X
XX Ratings
#XX
Education
3 + 3 = 6
Kid-Tested,
Educator
-Approved
Add &
Subtract!
Count!
Write!
Time!
Patterns!
10 20 30
Developed by Certified Experts
in Education
10 + ? = 16
Offers iPhone App
Our app helps your kid enjoy math. It's Math Time offers an exciting journey of math practice, enhancing kids' confidence and skills in math.
It's Math Time is developed by certified experts in child development and math educators.
* This app is developed by researchers from world-class universities.
* This app was tested by teachers.
* This app is approved by experienced educators.
Developer
XXX.Inc
Information
Seller
Size
123.8 MB
Category
Education
Compatibility
Works on this iPad
Languages
English and 32 more
Age Rating
4+
Today
Games
Apps
Updates
Search

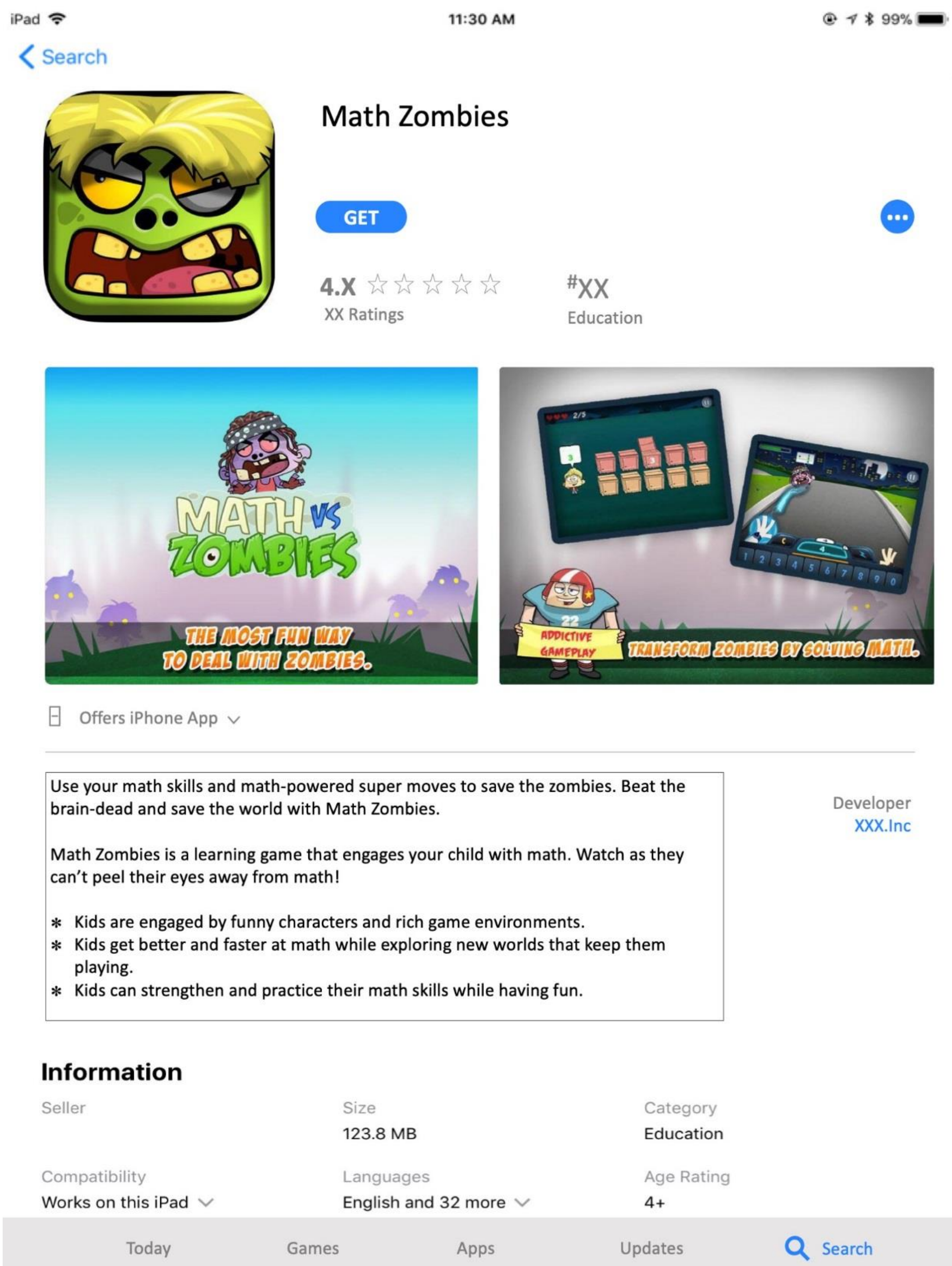

iPad
11:30 AM
99%
Search
Magical Math Bird
GET
X.X
XX Ratings
#XX
Education
GREAT WORK!
CONGRATS, YOU'VE FREED
HERBERT!
HEAR ME SING!
INCORRECT ANSWERS:
RATING:
Offers iPhone App
Magical Math Bird makes math soar. Kids can gain confidence in mathematics while increasing their math performance and improving their math skills.
Magical Math Bird helps kids understand mathematical concepts by providing feedback.
* This app gives immediate feedback, stating whether your child's answer is correct.
* This app enhances learning by explaining wrong answers.
* This app provides corrective feedback to help guide kids towards the right answer.
Developer
XXX.Inc
Information
Seller
Size
123.8 MB
Category
Education
Compatibility
Works on this iPad
Languages
English and 32 more
Age Rating
4+
Today
Games
Apps
Updates
Search

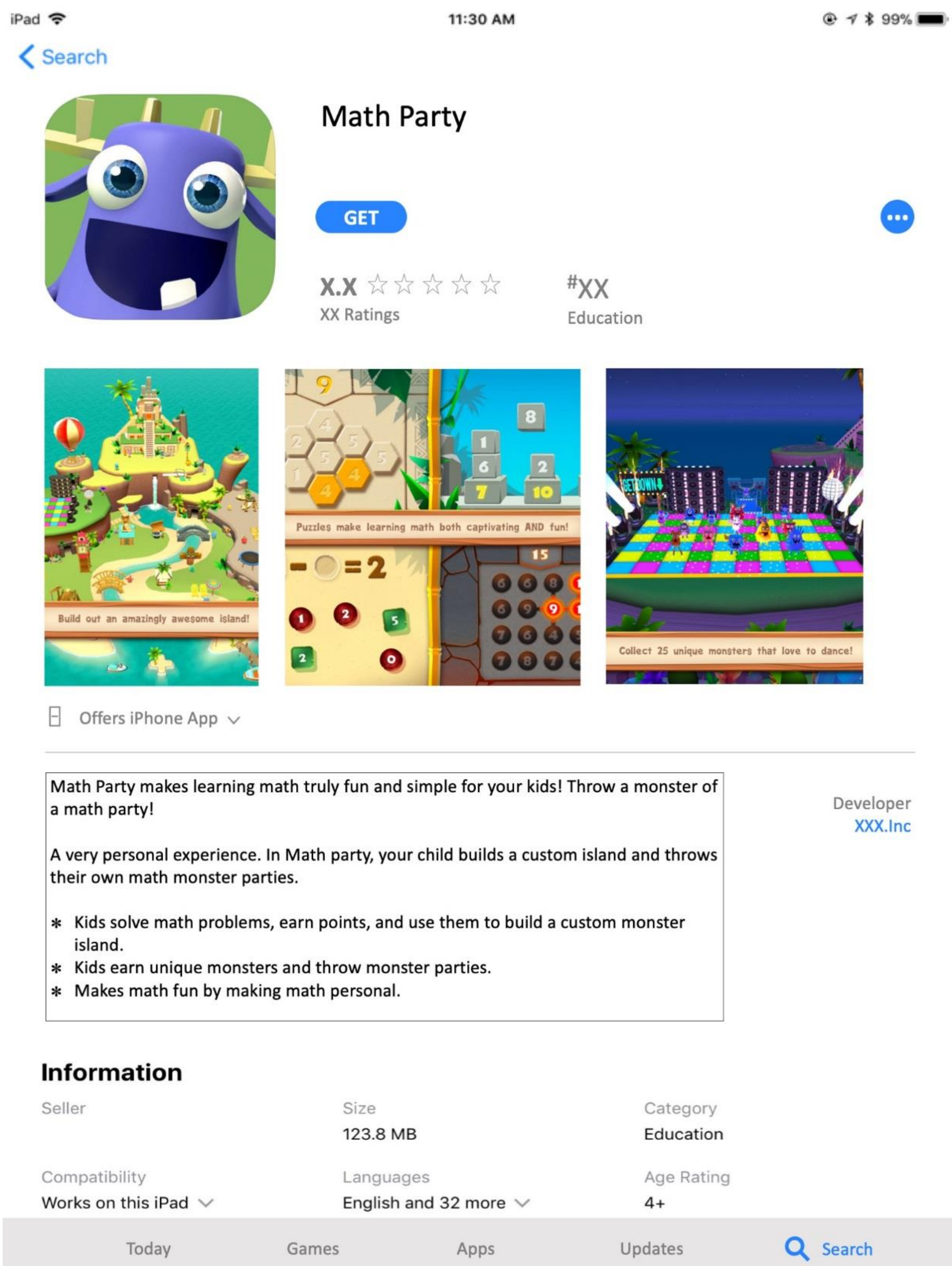

iPad
11:30 AM
99%
Search
Let's Play Math
GET
X.X ☆☆☆☆☆
XX Ratings
#XX
Education
SECRETLY TEACHES ALGEBRA
Using a learning theory
AFTER 1 HOUR
While kids play
AFTER 4 HOURS
Offers iPhone App
Math is all fun and games with us. Let's Play Math helps kids understand math, improves children's math performance, and enhances their confidence.
Let's Play Math is created using an evidence-based theory for how children learn math.
* This app's learning theory is based on discovery and experimentation.
* In the theory, kids learn math by solving equations through play.
* The theory helps kids learn at their own pace.
Developer
XXX.Inc
Information
Seller
Size
123.8 MB
Category
Education
Compatibility
Works on this iPad
Languages
English and 32 more
Age Rating
4+
Today
Games
Apps
Updates
Search


iPad
11:30 AM
99%
Search
HMH
Math Monster
GET
X.X
XX Ratings
#XX
Education
LEVELS
Addition
Multiplication
MASTER ALL LEVELS
IN ADDITION AND MULTIPLICATION.
BUILD CORRECT ADDITION
EQUATIONS TO FEED SUSHI MONSTER.
Offers iPhone App
Have fun with math in Math Monster! Kids become more confident and perform better after interacting with Math Monster.
Math Monster is a fully interactive learning experience.
* Kids quickly place sushi pieces near the monster to match the target number.
* By listening and responding to the math monster kids become math masters.
* Kids earn points, stars, trophies, and personal bests to challenge themselves and unlock new levels.
Developer
XXX.Inc
Information
Seller
Size
123.8 MB
Category
Education
Compatibility
Works on this iPad
Languages
English and 32 more
Age Rating
4+
Today
Games
Apps
Updates
Search


iPad
11:30 AM
99%
Search
Be A Math Star
GET
X.X
XX Ratings
#XX
Education
GEOMETRY AND MEASUREMENT
Offers iPhone App
Give your kids a solid math foundation with Be a Math Star. This app makes it easy and fun for your kids to enter the wonderful world of math.
Be a Math Star uses multi-media to bring math to life; turning numbers into colorful and real-life elements and representations.
* The app contains visual and audio activities to explore math.
* Kids get star points as they progress and feel like a real star.
* Kids acquire their ability to match numbers to what they see and hear.
Developer
XXX.Inc
Information
Seller
Size
123.8 MB
Category
Education
Compatibility
Works on this iPad
Languages
English and 32 more
Age Rating
4+
Today
Games
Apps
Updates
Search


iPad
11:30 AM
99%
Search
Math Fox
GET
X.X
XX Ratings
#XX
Education
Strength your math
7 5 9
2 + 5 = ?
SCORE: 0
HIGH SCORE: 0
TIME: 95
STRIKES:
Practice your math
4 + 5 = ?
SCORE: 20
HIGH SCORE: 310
Offers iPhone App
Experience a day with Math Fox? Would you like to solve puzzles with Math Fox while practicing math?
Math Fox is a hands-on learning experience; your child will be delighted while getting a head start in school.
∗ Kids solve math puzzles with hands-on activities.
∗ By moving number blocks, kids solve math problems with their hands.
∗ Kids are delighted by animations that respond to their touch.
Developer
XXX.Inc
Information
Seller
Size
123.8 MB
Category
Education
Compatibility
Works on this iPad
Languages
English and 32 more
Age Rating
4+
Today
Games
Apps
Updates
Search


iPad
11:30 AM
99%
Search
Math Zombies
GET
4.X
XX Ratings
#XX
Education
MATH VS ZOMBIES
THE MOST FUN WAY TO DEAL WITH ZOMBIES.
ADDICTIVE GAMEPLAY
TRANSFORM ZOMBIES BY SOLVING MATH.
Offers iPhone App
Use your math skills and math-powered super moves to save the zombies. Beat the brain-dead and save the world with Math Zombies.
Math Zombies is a learning game that engages your child with math. Watch as they can't peel their eyes away from math!
* Kids are engaged by funny characters and rich game environments.
* Kids get better and faster at math while exploring new worlds that keep them playing.
* Kids can strengthen and practice their math skills while having fun.
Developer
XXX.Inc
Information
Seller
Size
123.8 MB
Category
Education
Compatibility
Works on this iPad
Languages
English and 32 more
Age Rating
4+
Today
Games
Apps
Updates
Search


iPad
11:30 AM
99%
Search
Math Party
GET
X.X ☆☆☆☆☆
XX Ratings
#XX
Education
Build out an amazingly awesome island!
Puzzles make learning math both captivating AND fun!
Collect 25 unique monsters that love to dance!
Offers iPhone App
Math Party makes learning math truly fun and simple for your kids! Throw a monster of a math party!
A very personal experience. In Math party, your child builds a custom island and throws their own math monster parties.
* Kids solve math problems, earn points, and use them to build a custom monster island.
* Kids earn unique monsters and throw monster parties.
* Makes math fun by making math personal.
Developer
XXX.Inc
Information
Seller
Size
123.8 MB
Category
Education
Compatibility
Works on this iPad
Languages
English and 32 more
Age Rating
4+
Today
Games
Apps
Updates
Search

Appendix E

Study 2 Online Recruitment

How Parents Choose Educational Apps for their kids

Researchers at McGill University are currently recruiting English-speaking parents of children between 4-11 years-of-age to participate in a research study by @TekLrnCogLab to understand **how parents choose educational apps for their children.**

To learn more about the research team conducting the study click here: https://mcgill.ca/tlc

To participate in a study on how parent's choose educational apps, please click below. Details on the study will be provided prior to your participation.

(Link to study)

By participating in this study, you will be entered in a draw for a $50 App Store gift card (odds of winning = 1/500).

Appendix F

Study 2 Consent Form

McGill Department of Educational and Counselling Psychology in the Faculty of Education Département de psychopédagogie et de counseling de la Faculté des sciences de l'éducation

Title of Study: Why this app? How parents choose a good educational app.

Principal Investigator: Professor Adam K. Dubé
adam.dube@mcgill.ca
Assistant Professor, Learning Sciences Program
Department of Educational & Counselling Psychology
McGill University

Research Team: Armaghan Montazami, Master student

Sponsor: McGill Internal SSHRC Development Grant

Purpose of the Study: There are over 80,000 educational apps in the iTunes app store and these apps are of varying levels of quality. Some are effective but many are not. Considering that parents often choose which apps their children use, we want to understand how parents choose educational apps (e.g., a math app for a smartphone). App Stores provide a lot of information about an app, and by completing this study you will help us determine which information parents value.

Participants: You are being asked to participate in the study because you are parent/guardian of children between 4-11-years-of-age.

Procedures: If you agree to participate in this study, you will complete a short demographic survey (e.g., age, gender, number of children). Then, you will be shown 10 different educational apps and asked questions to gauge your opinion of these apps (e.g., "Would you download it?", "How would you rate it?) and "At what price would you like to download this app". Then, you will be asked to rank the apps from best to worst.

The "Why this app?" survey is completed entirely online, requires approximately 15 minutes to complete, and does not require any follow-up participation. The data from this survey will be coded and encrypted to ensure it remains confidential. "*This study has been reviewed and approved and for ethical compliance by the McGill University Research Ethics Board*". General results will be made available to you on request.

Benefits of Participation: Possible benefits from study participation include an opportunity to reflect on how you choose educational apps.

Risks of Participation: There are no risks associated with participating in this study.

Cost /Compensation: Participants who submit the questionnaire will be entered in a one-time draw for a $50 CAD gift card to the App Store of their choice. Estimated odds of winning, 1/500.

Contact Information/Questions: If you have any questions or concerns about the study, you may contact the Principle Investigator, Professor Adam K. Dubé (teklrncog@gmail.com).

If you have any ethical concerns or complaints about your participation in this study and want to speak with someone not on the research team, please contact the McGill Ethics Manager (lynda.mcneil@mcgill.ca; 514-398-6831) referencing REB #412-0319.

Voluntary Participation: Your participation in this study is voluntary. You may refuse to participate in this study and you may withdraw from the study at any time without prejudice to your relations with the university. If in any case that you don't feel comfortable answering the questions, you may click the option "skip to the next question". You are encouraged to ask questions about this study at any time prior to or after the study via email.

Confidentiality: The identifying information below (your email) will be collected only for the purpose of the informing prize draw winner and will be omitted immediately following the prize draw. Accordingly, your participation in this study is completely confidential and all questionnaire responses will be kept completely confidential. No reference will be made in written or oral materials that could link you to this study. All digital records will be saved in password encrypted files in a locked facility at McGill University for at least 7 years following study completion at which time it will be destroyed. In the event that data is destroyed before 7 years, participants will be informed. For information on the limited risk of access to data on U.S. web servers afforded by the U.S. Patriot Act, please visit https://blog.surveymonkey.com/blog/2011/05/10/patriot-act. Access to participants' anonymized data will be limited to members of the research laboratory of Professor Adam K. Dubé.

Please click "Yes" below if you have read the above information and consent to participate in this study. Agreeing to participate in this study does not waive any of your rights or release the researchers from their responsibilities. A copy of this consent form will be emailed to you and the researcher will keep a copy. To ensure the study is being conducted properly, authorized individuals such as a member of the Research Ethics board, may have access to your information. By clicking "Yes", you are allowing such access.