

# Mobile Applications for Promoting Visual Perceptual Skills: A Systematic Review

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## INTRODUCTION

Information technology has become a vital part of people's everyday lives. It has long been utilized and integrated in entertainment and business industry. Mobile applications currently have become more popular and commonly seen in education and healthcare settings. The benefits of technology are well documented in children's learning and development [1]. Early childhood educators and healthcare practitioners such as pediatric occupational therapists (OT) incorporate the mobile apps into their sessions to promote young children's development and skills. One of occupational therapist's roles in educational and rehabilitation settings is to utilize assistive technology to support student academic success and independence. Literature shows that mobile apps are being integrated into occupational therapy practice [2, 3, 4, 5] and more than 50% of OT practitioners utilize apps in their practice [6]. A mobile app is incorporated in occupational therapy as one of the therapeutic tools. Pediatric OT practitioners have utilized the mobile apps in their practice to promote the following skills in children: gross and fine motor skills, cause-effect skill, organization skills, sequencing skills, handwriting skills, and visual perceptual skills. Literature suggests that they can be effective in promoting a variety of academic skills and other developmental areas in children [7, 8, 9].

Mobile apps designed for young children increasingly become available and many parents, educators, and therapists have adopted the apps into their homes, schools, and therapy settings. Due to the significant increase in number of apps available, these users will have to spend a lot of time in searching for the right app to use with their child. Therapists in particular can feel overwhelmed in the amount of time spent on looking for a useful app to utilize in their practice when there is limited evidence in guiding this clinical decision making [4]. Therefore, it is essential that these available apps as well as their features be reviewed and analyzed systematically to inform these users in making decision about the apps' applicability, usefulness, functionality, and appropriateness for use in young children population.

In this present paper, the authors focus their systematic review and analysis on the accessible apps that have visual perceptual components designed for use in young children in order to inform and guide the users and developers of the apps' features.

## METHODS

To investigate features of apps currently available for iPad, a systematic search was conducted in the Apple app store in November 2017. The authors searched for apps using the following keywords: visual perceptual, visual perception, early learning, early education, and pre-school learning. Apps were deemed eligible if they met all of the following criteria: 1) available for download through official Apple app store, 2) the app has at least one visual perceptual component, 3) the audience should be young children (5 years old and under), 4) the app is in English, 5) the app was last updated no earlier than 2015, and 6) it has at least 20 ratings. The authors used ratings and recent updates to exclude the apps that are not well maintained or heavily used.

The initial search identified over a hundred apps on the Apple app store. The first two authors independently screened each app by examining its description and screenshots. The initial list of apps was then discussed in a group session to determine which app met the inclusion criteria. After screening and discussion, 13 apps were selected for an in-depth feature analysis. Apps meeting the inclusion criteria were then downloaded onto an iPad and all three authors performed the analysis of apps through use of the app. These apps and their short names are presented in Table 1.

## RESULT

This section describes the general characteristics and features of 13 mobile apps that were identified through systematic review.

### General characteristics

Of the 13 included apps, five are classified as education on the Apple app store, whereas the rest are categorized as game app. After examined the content of each app, the authors found that six apps incorporate a variety of

puzzles as the main tasks, and the rest of the apps include matching and sorting activities. All apps require a child to move his/her finger to tap, trace over, or draw a shape while doing the task. Moreover, no apps offer any information on screening or assessing children’s visual perceptual skills. According to the app store descriptions, all apps were developed for typical children.

**Table 1. Applications reviewed and their features**

App Name	Short Name	Reward System	Parent Involvement	Different Levels of Difficulty	Engaging and Interactive	Feedback
Shapes! Toddler kids Games, Baby Boys	A1	✓		✓	✓	
ABCmouse.com	A2	✓	✓	✓	✓	✓
Kids ABC Shapes Toddler Learning Games	A3	✓			✓	
Puzzingo Toddler Kids Puzzles	A4	✓		✓	✓	
Shapes & Colors Learning	A5	✓			✓	
Dino Puzzle: Kids Dinosaurs Puzzles	A6	✓	✓	✓	✓	
Shapes Toddler Preschool	A7	✓	✓	✓	✓	✓
Shape Puzzle	A8	✓			✓	
Amazing Shapes Puzzle	A9	✓			✓	
Preschool Kindergarten Games	A10	✓			✓	
Raccoon Treehouse	A11	✓			✓	
Caillou House of Puzzles	A12	✓		✓	✓	
Shape Puzzle learning games for Toddler kids	A13	✓		✓	✓	

**App feature analysis**

The apps were reviewed using 5 essential features, which include reward system, parent involvement, different levels of difficulty, engaging and interactive, and feedback (Table 1). Below are definitions and detailed discussion on each app feature.

*Reward system* is an incentive or a favorable response a child receives after performing certain actions within the app. It was found that all apps use this feature to encourage children to complete activities, especially challenging activities. Different types of rewards are used by those apps, including points, badges, medals, praise and direct positive items such as stars, balloons, stickers, etc. In addition to rewarding children, a few apps also allow the children to use the rewarded items to “purchase” virtual items (A2) or build their own design (A7) in the app.

*Parent involvement* occurs when a parent can customize or set up a feature or material within the app according to the child’s needs or levels. Involving parents in the use of app would not only provide a better experience for a child, but also help parents see firsthand that the app is beneficial for their child [10]. However, very few apps (N = 3) provided an option for parent to get involved in their child’s use of the app. The most commonly seen parent involvement is that parents can go to the settings to choose different activities or difficulty levels for their child. For example, A6 allows the parents to select different types of puzzles and different difficulty levels (e.g., puzzle size).

*Levels of difficulty* refers to different levels within the app that a child can achieve using different efforts or abilities. It was found that half (N = 7) of the apps have different difficulty levels. For example, the level of difficulty increases as the number of pieces of puzzles for a task increases (A12). Other apps, however, only provide different tasks with the same or similar level of difficulty.

*Engaging and interactive elements* refer to features within the app that can keep a child engaged such as colorful animation, sound effect, narration, bright colorful graphic, and a mascot. All the apps were found to use different elements to engage children. For example, once the child completes a task, he or she will receive positive reinforcement such as “excellence” or an applause.

*Feedback* refers to a feature within the app that enables a child or parent to see the child’s progress. Only two apps provide this feature, which allows parent to monitor and interpret the child’s progress. For example, A2 has a specific feature called “progress tracker”, which uses bar, pie charts, line graphs and other visualization modalities to help parent get an overview of their child’s progress and learning activities. In contrast, A7 provides a feature called “report card”, which would send child’s performance to parent’s email account; the parents then can choose to share with pediatric occupational therapist for further discussion.

## **DISCUSSION AND CONCLUSION**

With the widespread use of mobile technologies, there is an opportunity for parents, educators, and pediatric occupational therapists to use mobile applications to promote children’s visual perceptual skills and monitor the performance of children who have visual perceptual disabilities. However, there has been limited systematic investigation into what mobile technologies can be used and what essential features should be implemented in the app. Our findings highlight important shortcomings in current available apps for promoting visual perceptual skills. For example, we found that most apps have engaging elements and reward systems but few apps provide appropriate features for supporting parent involvement and feedback. There is an opportunity for mobile developers, researchers, and healthcare providers (e.g., occupational therapists) to work together towards developing usefulness, robustness, and evidence-based apps for young children population.

### **Limitations and future work**

We reviewed the apps that were only available on Apple app store. We did not examine the Google Play store. This is part of our future work. Another possible limitation is that we didn’t review the quality and appropriateness of tasks in each app. In the future, we will involve healthcare providers, i.e., occupational therapists, to evaluate the content of each app.

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