The Development of Interactive Book Apps to Teach Young Children Mathematical Concepts

Cathy Weng[1] and Apollo Weng[2]

[1] National Taiwan University of Science and Technology,
Graduate Institute of Digital Learning and Education,
43, Sec. 4, Keelung Rd., Taipei, 106, Taiwan
[2] China University of Technology, Digital Multimedia Design,
No. 56, Sec. 3, Xinglong Rd., Wunshan District, Taipei City 116, Taiwan
{cathyhaien,libanweng}@hotmail.com

Abstract. Many studies have shown positive effects of using storybooks to teach mathematics on young children's attitude toward mathematical learning as well as their abilities and skills to solve mathematical problems. As technology advances, interactive electronic storybooks are also playing as key tools to enhance students' learning. The purpose of current study is to explore how to combine the characteristics of storybooks and the interactive technology to develop a highly interactive e-storybook App on iPad to enhance preschoolers' learning in numeric concepts. It is believed that this study on interactive math storybook Apps will give numerous benefits toward many individuals such as children, parent and teacher, instructional designers.

Keywords: Interactive e-book, Mathematical storybooks, Book App design.

1 Introduction

Many children do not like Mathematics, find it to be a difficult subject to learn, and have poor performances in schools. Mathematics difficulties are especially pronounced in students from low-income families [1]. Researchers have found that children from low-income backgrounds enter school with much less mathematical knowledge and competence than their more affluent peers, and these early deficits tend to have long-term consequences. Early mathematical knowledge predicts students' math achievement test scores in elementary school, middle school, and even high school [2]. Some researchers even indicated the strong effect it has on a person's career advancement [3]. Moreover, according to Duncan et al. [2] the relationship between early and later mathematical knowledge is about twice as strong as that between early and later reading achievement. Thus, early Mathematical concepts and knowledge are so important in a person's life, and finding effective interventions to increase the impact and effectiveness of teaching and learning early mathematical knowledge presents an important challenge to researchers and teachers alike today.

In the past, cognitive scientists have argued that storytelling is the most natural way of delivering organized knowledge to human cognitive system, and when the

information is presented within a story context, rather than in a decontextualized format, it usually can be learned and retained more effectively [4], and this effect is quite robust [5]. The use of storybooks to support children's learning, and the research that investigates this, generally focuses on learning related to language development, such as early literacy concepts [6]. However, in 1989, National Council of Teachers of Mathematics started to advocate the use of children's trade books (storybooks) as a way of introducing mathematical ideas [7], and linking mathematics instruction to children's literature has become increasingly popular since then. In fact, when linking up young children's love of fantasy to the learning of mathematics, teachers can make mathematics meaningful to them. Many empirical findings also suggested that it is useful to embed the mathematics in a story context, and to develop mathematical concepts through sequenced mathematics problems connected to the storyline and the pictures [4]. According to Schiro [8], with those stories and mathematical literatures, children can not only be provided with a context for making meaning of abstract mathematical concepts but also taught the importance of mathematics in their world and even changing their attitudes toward mathematic concepts. Thus, using stories to enhance students' Mathematical concepts is not something new, and it has been a widely accepted, sound strategy for the teachers.

As the technology becomes more and more advanced, storybooks can appeared as electronic books have interactive components that allow children to deviate from the story sequence by clicking on hyperlinks or hotspots that activate sound effects, oral reading, animations, games, music, or other interactive features. Electronic books can take many different forms from talking books to CD ROMs, or today as book apps. The word "app" is an abbreviation for "computer application," which is a computer program that is accessed through an icon on the tablet computer screens. Recently the term "app" has taken on a whole new meaning as Apple Computers have developed programs for their computers, iPads, iPods and iPhones that include everything from games, websites, television stations, and now books. Here, the book app is an interactive storybook used on mobile devices, and it is even more user friendly and allows more direct experience for the user through the touch of the screen with their fingers to control the device. In the past, learning software has been well recognized for its ability to increase a child's independence and sense of control over their learning, which increases motivation and self-esteem [9]. Nowadays, when the electronic storybooks are developed as book apps, they will give users even more possibilities, as they are more flexible and accessible.

Under this current study, the authors develop a book app that is "born digital" as compare to most of the electronic books are still digitalized form of the printed book. This means that more interactive multimedia features will be utilized. The book app wants to create mathematical connections to real world situation through an adventure story that teaches numerical concepts for preschoolers, and hope it will engage them and make them learn. In the following section, it would be focused on introducing how this book app was developed.

2   The Development of the Book App

The Model of the Instructional Design. The development of the book app was based on the backward design discussed by Wiggins and Mctighe [10]. It is a three-stage approach to planning, where at stage one, we carefully identify desired results. Various numerical concepts were identified for our target audience that is the preschoolers, following on the standards announced by the Ministry of Education in Taiwan. The second stage is determining acceptable evidence. At this point, we focused on how to measure student's successful learning of those concepts. Finally at the third stage, with clearly identified results and appropriate evidence of learning, it was then the time to fully think through the most appropriate instructional activities. Here will be the actual story content developed. In order to establish an interesting and comprehensible story to teach preschool numerical concepts, the story content developed are actually following Thorndyke's [11] story grammar (see Table 1) that is a framework of elements that helps to organize oral and written works of literature so that information may be stored and retrieved easily. These elements and their rules of combination comprise a framework or schema that describes the organization of most narrative texts. By including all the elements and grammar rules, the book app developed would be a more complete and motivating story.

Table 1. Grammar Rules for Simple Stories [11]

Rule #	Rule
1	Story -- Setting + Theme + Plot + Resolution
2	Setting -- Characters + Location + Time
3	Theme -- (Event)* + Goal
4	Plot -- Episode*
5	Episode -- Subgoal + Attempt* + Outcome
6	Attempt -- Event*/Episode
7	Outcome -- Event*/State
8	Resolution -- Event/State
9	Subgoal/Goal -- Desired State
10	Characters/Location/Time -- State

The symbol "+" specifies the combination of elements in sequential order. The parentheses around Event show that the element is optional and the asterisk (*) indicates that the elements may precede the statement of the goal.

The Developmental Platform of the Book App. The Book app was constructed on two multimedia book-app design platforms, Presentation and Mocol, by Chidopi Co., Ltd. in Taiwan. Presstation allows users to post stories, upload photos, videos, music, or website links to create interactive iPad ebook apps. It is a user-friendly tool and users do not need to have a programming background. On the other hand, MoCool is also an automatic app maker platform. It allows easily transfer of contents into App

format. It allows digital contents to take full advantage of the finger-tap capabilities of the various mobile devices. The MoCool platform is using updated HTML5 as core technology presenting contents and effects efficiently and productively. The powerful effect engines and modules help content writer spread their creativity without knowing any technical codes. It can also support multimedia, rich interactions, and animations by uploading raw materials such as images, videos and texts [12].

Fig. 1. The screen shots from the actual book app presenting numerical concepts

1. The title page of the book app, Kong Fu Monkey-The Development of numeric cognition.
2. Conversation will be shown with printed text as well as sounds in the dialogue boxes.
3. Blinking on the flowers leads the reader touching with their fingers, and it will count the flowers with the printed symbols.
4. Using objects appeared in kids' daily lives, it utilizes the familiarity to attract preschoolers' attention
5. Reader can use their fingers to swipe and flip to the next page

The Description of the Mathematic Content and the Story Covered in the Book App. What is innovative about the book app, "Kong Fu Monkey", is that the storytelling is in the form of an adventure story that starts with three friends who wanted to learn Chinese Kong Fu, so they follow a mysterious bird leading them to find the Turtle Master for the lessons. This format allows the numerical concepts to be taught in a systematic, hierarchical progression. The story is interwoven with the targeted numerical concepts (counting, number knowledge, number transformation, estimation, and number patterns) and extends over several lessons, so that they provide a medium for ongoing instruction and deepening mathematics understanding for the children. Through the animated pictures and hearing dialogues, the readers can comprehend the presentation and the analytic explanation of the involved basic concepts. In the story, the characters (the three friends) also encounter multiple obstacles, each building upon the previous, in terms of both story plot and math content. By teaching these skills in the carefully written story context including what is familiar, children would be able to make connections to the real world and daily experiences.

Each lesson is presented in the form of a new problem that the readers must follow the characters to solve in order for the story to progress. This draws the children into the action of the story, actively engaging them as critical participants as the drama unfolds. Therefore, they are more invested in solving the problems occur in each section and motivated to utilize their intellectual abilities in the acquisition of new knowledge and skills.

3   Conclusions

With carefully designed story and the interface of the book app, it is believed that the book app developed in the research will bring great benefits to the preschoolers' learning on numeric concepts. The present findings suggest a future direction for early childhood mathematics education. The use of a story context provides an important conduit for communicating mathematical ideas. However, in order to have empirical evidence on the effectiveness of this book app, further investigation is needed on some kind of experiment carried out with real preschoolers.

References

1. National Assessment of Educational Progress. The nation's report card. Mathematics highlights 2003 (No. NCES2004-451). US Department of Education, Jessup (2004)
2. Duncan, G.J., Dowsett, C.J., Claessens, A., Magnuson, K., Huston, A.C., Klebanov, P.: School readiness and later achievement. Dev. Psy. 43, 1428–1446 (2007)
3. Jordan, N.C.: Early predictors of Mathematics achievement and Mathematics learning difficulties. Encyclopedia on Early Childhood Development (2010)
4. Schank, R.C., Abelson, R.P.: Knowledge and memory: The real story. In: Wyer, R.S. (ed.) Knowledge and Memory: The real story, pp. 1–85. Lawrence Erlbaum Associates, Hillsdale (1995)
5. Mishra, A.: Age and school related differences in recall of verbal items in a story context. Soc. Sci. Inter. 19, 12–18 (2003)
6. Anderson, A., Anderson, J., Shapiro, J.: Supporting multiple literacies: Parents' and children's mathematical talk within storybook reading. Math. Edu. Res. J. 16(3), 5–26 (2005)
7. National Council of Teachers of Mathematics: Curriculum and evaluation for school mathematics. National Council of Teachers of Mathematics, Reston (1989)
8. Schiro, M.: Oral storytelling and teaching mathematics: Pedagogical and multicultural perspectives. Sage Publication, Thousand Oaks (2004)
9. Moody, A.K.: Using Electronic Books in the Classroom to Enhance Emergent Literacy Skills in Young Children. J. of Lit. and Techf. 11(4), 23–52 (2010)
10. Wiggins, G., McTighe, J.: The Understanding by Design guide to creating high-quality units. ASCD, Alexandria (2011)
11. Thorndyke, P.W.: Cognitive structures in comprehension and memory of narrative discourse. Cognitive Psychology 9, 77–110 (1977)
12. Chidopi (April 10, (2013),
    `http://www.chidopi.com/site/services-2/mocool/?lang=en`,
    `http://www.chidopi.com/site/services-2/mocool/?lang=en`
    (retrieved)