



# Gamification and serious game approaches for adult literacy tablet software <sup>☆</sup>



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## ABSTRACT

In this paper, we overview the design of tablet apps we designed and built to teach literacy to adults, and present the results and conclusions derived from experiments performed with target users. Low adult literacy is a significant problem with a high economic cost both for the individuals and for society. Programs created to address low adult literacy face access and engagement barriers that tablet software may be able to help overcome. We designed three tablet apps, using two contrasting approaches of incorporating game-design elements to engage the users. We tested the apps with participants from the Brant Skills Centre, a non-profit organization that offers adult literacy programs in Brantford, Ontario. Though participants were divided on whether they preferred the apps to more traditional instruction, most participants preferred using the apps in addition to more traditional instruction. Based on this we conclude that gamification and serious game design approaches were effective at increasing learner engagement, and we propose a direction for future research.

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## 1. Introduction

The high prevalence of low literacy skills in adults has serious negative consequences for society and the individuals affected. Literacy is frequently measured on a scale of 1 to 5, with level 3 being equivalent to high school completion and considered by experts as the minimum required for coping with the increasing demands of the information economy [1]. The International Adult Literacy and Skill Survey found that 48% of the Canadian population over 16, representing 12 million people, have literacy skills below this level [2].

The employment, economic and health impacts of low literacy skills have been extensively documented by international and national organizations [3,4]. We highlight a few statistics here to illustrate the scope of the problem. People with low literacy skills are more likely to have lower rates of employment and to work in low-skill jobs; roughly 57% of Canadians age 16–65 at a level 1 literacy level were employed compared to about 70% at level 2 and more than 80% of those at levels 4–5 [2]. In the USA, a 2005 report by the National Assessment of Adult Literacy found that 93 million

people lack the literacy skills required to complete the education or job training required by current and future jobs [5]. With employment growth polarizing into high-skill, high-wage jobs and low-skill, low-wage jobs due to automation of routine tasks by computer software and off-shoring of middle-skill jobs [6], the employment prospects of low-literacy workers will likely only become worse in the future. In the USA, an estimated \$106 to \$238 billion dollars in annual health-care costs can be attributed to poor health knowledge and behaviour resulting from low literacy [7,8].

The total potential enrollment and drop-out rates of programs designed to address low literacy are disappointing. Less than half of those who reach out to a literacy organization register for a program, and of those 30% will drop out [9]. Under 10% of Canadians who could benefit from a literacy program enroll [4], with job, money problems, lack of childcare and transportation cited as reasons.

Tablet computers have recently exploded in popularity, reaching 116 million in sales worldwide in 2012 and are projected to grow to 468 million by 2017 [10]. These devices provide an opportunity for novel and disruptive approaches to the problem of low adult literacy. Tablet software may be more cost effective than human instruction, alleviating the resource issue. A tablet can provide an interactive learning experience that doesn't require the learner to leave home, alleviating the lack of childcare and transportation issues. Tablet software may also provide a more fun

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and engaging method of learning that could increase adult participation in literacy education and/or lower literacy-program drop-out rates. Tablet devices offer a direct-control user interface (touchscreen) that could be easier to use, particularly for low-literacy users, than traditional PC or laptop home computers with keyboards and indirect pointing devices (mice, touchpads). Finally, Megalingam et al. have proposed a tablet device called EduPad to reduce rural adult illiteracy in India [11], motivated by the idea that the device could make up for a lack of qualified personnel or adequate infrastructure.

In this paper we explore using iPad software to teach literacy skills to low-literacy adults, motivated by the above situation and possible opportunity. For this we sought out existing literature on educational iPad software design and user experience, and on using gamification as a design approach due to its claim of influencing user behavior and increasing engagement.

Kayne Toukonen looked at how the features of a tablet device could facilitate learning in the form of what he termed *dynamic electronic textbooks* [12]. Toukonen pays particular attention to Brian Cambourne's eight Conditions of Learning [13] that Cambourne felt necessary for the acquisition of language, connecting each of these eight conditions to the possible software features enabled by tablets. For example, it is suggested that the learning condition *engagement* can be facilitated by using virtual worlds in tablet applications.

There have been some studies analyzing the effectiveness of tablets for education. For example, Houghton Mifflin Harcourt conducted a year-long pilot study in a middle school in Riverside, California in which an iPad application was used to increase student performance by 20% in algebra compared to peers who used textbooks [14]. In work by Sarah Henderson and Jeff Yeow, a New Zealand primary school used iPads in classrooms with students aged 5–12, and they reported that the low learning curve, high portability, and instant boot-up time of the iPads were recognized as positive aspects of using the tablets as learning tools [15]. Henderson and Yeow's findings and that of others [16] focus less on the effectiveness of the design of any particular application but more so on the aggregate results from using iPads as a learning tool; for example, the organizational challenges that using the tablets present.

The authors have previously created iPad apps for secondary and introductory post-secondary computer science education with promising results. A common design approach in these apps was having the user *learn-by-doing*; the user would manipulate representations or simulations of a problem domain. We believe this design approach is best described as experiential learning. Though experiential learning has several definitions, properties and models [17], for the purposes of our software we focus on the fundamental feature of learning through the application of concepts in an interactive setting.

Gamification is another design approach which has produced promising increases in engagement in several different contexts. Gamification can be defined as the “usage of game design elements to motivate user behaviour in non-game contexts” [18]. A well-known example would be the location-based social network Four-square that rewards users for checking in to their current location with points and allows the user to become the “mayor” of that location. Other examples include startup company ZamZee [19] that was able to use a gamification-based app to increase physical activity in children by 60%, and the Greater Washington Give Day who were able to use gamification to drive 2 million dollars in fundraising in one day [20].

While it's clear gamification has produced some promising results, the design approach does come with significant risk. One of the world's leading IT research and analysis companies, Gartner has warned that 80% of all gamification apps will fail to meet their

objectives due to poor design [21]. There has also been little academic research into the definition of gamification itself, and whether it constitutes a truly new and distinct phenomenon. One can also distinguish between gamification and “serious games”, that is a full-fledged game for non-entertainment purposes, but this boundary is subjective.

There have been a few studies looking at educational-tablet game software. Wattanatchariya et al. developed a game called “Drop Donuts” for teaching wind and gravity concepts and report on survey results from 12 university student participants [22]. Feng Yan developed an iPad application “A Sunny Day” to educate children with autism, which features mini-game and puzzle-game elements, and tested it with autistic children and their parents [23]. Yan's work is especially valuable because of attention to application-design elements, to testing of the interface with target users, and reporting on what did and didn't work and why. For example, their analysis suggests that the software should have had clearer objectives and provided rewards more quickly after completing tasks. The paper concludes that the app offers a cost-effective therapeutic approach relative to existing methods. We were not able to find similar work examining gamification approaches to adult-literacy tablet software and consider this a significant gap in the literature that demands exploration.

In this paper, we present the design and user experience experiment results for three iPad applications developed to teach literacy concepts to low-literacy adults. The apps incorporate game-design mechanics in different ways, and we hypothesize using these apps will improve the educational experience through increased motivation, engagement, and learning. The study was done in conjunction with the Brant Skills Centre, a non-profit organization that provides programs for literacy and other essential skills for adults in Brantford, Ontario. In Section 2, we present the design of the applications and how they incorporate game mechanics. In Section 3, we discuss the design of the experiment that took place. In Section 4, we provide the the results of this study, and in Section 5 we conclude that learner engagement was improved and propose a direction for future research.

## 2. Application design

Three apps were designed to teach literacy concepts to experiment participants from the Brant Skills Centre. Because the clients of the Brant Skills Centre were at varying levels of low literacy, we chose to focus on three areas that tended to be problems across these levels: homophones, punctuation (period, question mark and quotation placement), and comma placement. All of the apps incorporate some form of experiential learning by having the user *do* what the app is trying to teach them. The homophone app and punctuation app were developed with two contrasting approaches to gamification of educational software. The comma placement app was actually developed in response to experiments conducted with the homophone app, as explained in Section 4.

In a paper focusing on the definition of gamification, Deterding et al distinguish between gamification from serious games as follows, “what distinguishes gamification from regular entertainment games and serious games is that they are built with the intention of a system that includes elements from games, not a full game proper” [24]. The homophone app is intended as an educational app that includes elements of gamification to motivate user behavior, whereas the punctuation app is intended as a serious game where literacy-skill improvement is the primary goal rather than entertainment. The design of the homophone app was most influenced by Cambourne's conditions of learning, and the design of the punctuation app was most influenced by the concept of flow [25].

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