

# Comparison of effectiveness of two mobile application designs for encouraging children to read.

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## ABSTRACT

Many South Africans are functionally illiterate, which impacts adversely on their further education and job prospects. As literacy deficits begin in primary school, it is vitally important to improve reading engagement in children aged 6 to 13 years.

In this study, we explored the use of mobile applications to improve children's engagement with, and enjoyment of, reading. Two alternative approaches were prototyped: the *StoryMaker* tablet application allows children to create a digital story book incorporating characters from the popular Nal'ibali reading-for-enjoyment supplements, while the *StoryGame* application uses a less traditional gamification approach, where the user directs a character through a story by solving word problems.

The applications were tested on groups of children aged 10 to 12. While both applications met with enthusiasm, the children reported that the *StoryGame* application encouraged them to read more, while they would prefer to play with the *StoryMaker* application. The long-term benefits of these applications are still to be established, but this pilot study should inform the design of future applications to encourage reading in children.

## CCS Concepts

• Human-centered computing → Interaction design • Human-centered computing → Ubiquitous and mobile computing.

## Keywords

Gamification; Nal'ibali; Education; Storytelling; Literacy; Mobile applications;

## 1. INTRODUCTION

Literacy in South Africa is in a poor state [1]. Although the Progress in International Reading Literacy Study (PIRLS) reports literacy rates of 92% for South African citizens aged 12 to 24 [2], this survey has been much criticized for the manner in which it was conducted [3]: 18.958 million citizens (roughly 36% of the population of South Africa) with education higher than Grade 7 were excluded from the study and literacy was defined as the participants' self-reported ability to fill out a form. A report commissioned by the Centre for Development & Enterprise in

2011 gives a more accurate reflection of the state of South African literacy: only 25% of South African school-going children are functionally literate [4]. The report suggests that literacy deficits, which begin in primary school, have long term effects on later learning. It is therefore vitally important to improve reading engagement in children aged 6 to 13 years.

The Project for the Study of Alternative Education in South Africa (PRAESA) is an independent research and development unit affiliated with the University of Cape Town (UCT). In 2012, PRAESA launched a reading-for-enjoyment campaign called Nal'ibali [5]. The campaign is based on the premise that engaging children in storytelling leads to them forming a healthy appreciation for reading, which in turn improves their general literacy skills. This assumption is supported by discussion groups held by PRAESA in Rawsonville and Langa [6, 7], and a recent Australian study by Kalb et al. [8].

Nal'ibali aims to foster an enjoyment of storytelling through reading groups that make reading a social and cultural practice. Parents, community members and other role-models are encouraged to read with the children, and engage with them in telling the story. (Nal'ibali is driven by PRAESA, Times Media and a growing number of other partners.) In 2013, we began a project with the aim of developing a mobile application to assist the Nal'ibali Campaign. The goal was to create a software tool that children could access on mobile devices to encourage them to read and engage with storytelling. In keeping with PRAESA's research focus, the first goal of the project (reported here) was to establish an effective design for the mobile application, by implementing two alternative designs for the application and then evaluating and contrasting children's responses to these prototypes.

## 2. RELATED WORK

Games have long been recognized for the value they offer in teaching skills to children. From Fogg's 2002 book on how computers can be used to change our behaviour [9], to Pollak et al.'s 2009 study on the use of mobile games to promote healthy eating habits [10], there is a wealth of literature available to support the notion that games can be used to effect social change. The case of literacy is no different [11].

There have been a number of recent innovative approaches in improving literacy. Kothari and co-workers have pioneered the use of "Same Language Subtitling" (SLS) on Bollywood film songs on TV for mass literacy in India [12]. Another Indian study showed remarkable improvements in English literacy in both typical high-performance and typical low-performance learners after the introduction of a cellphone game to after-school tuition [13]. However, this study focused purely on the post-test gains of

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the app to the learners' English literacy skills and no attention was given to design aspects of the game, which could have improved or hampered the learners' improvement. Studies that have focused on the design of the games are often too abstract to be of much use to game developers [14]. For example, it is frequently mentioned that games need to introduce a "cycle of expertise" [14], but no mention is made of which implementation of this cycle is best for learning.

A successful educational game provides users with incentives to learn. Paras and Bizzocchi identified seven features that make for successful educational games: motivation, flow, game environments, play, endogenous fantasy, immersion and reflection [15]. Motivation should be intrinsic to the game design, as intrinsic motivation helps users continue to seek knowledge after the game is over. Flow describes a phenomenon whereby, in a sufficiently stimulating game, users experience homeostasis between challenge and frustration, with the end goal being clear enough to make obstacles ignorable [16]. The game environment must facilitate flow and be closely related to the learning content. Similarly, it must facilitate play, which is widely recognized as being an effective medium for early learning experiences [17, 18]. A marriage between the game environment and the learning experience can be achieved through endogenous fantasy around the scene in which the learning activity is embedded. This scene should be attractive and intriguing to the user. It should not merely improve the educational setting, which is known as exogenous fantasy [15], but integrate the learning content into the game environment. This helps to immerse the user in the game. Immersion in turn requires the user to voluntarily participate in the learning process. Finally, the game should allow the user the opportunity to reflect on what is being learnt. This facilitates active learning on the user's behalf.

### 3. DESIGN

As optimization of a particular design is a difficult task to quantify, we developed two alternative prototype designs for a mobile reading application that could then be compared and contrasted. During the design process, we worked closely with the Nal'ibali foundation. The prototype applications we designed as part of this process both integrate a number of the familiar characters that appear weekly in the popular Nal'ibali national newspaper supplement.

The two applications, *StoryMaker* (Figure 1a) and *StoryGame* (Figure 1b), use entirely different approaches to encouraging reading and storytelling. Developing these two alternative designs allowed us to explore whether the creative, flexible "graphic" format of *StoryMaker* or the dynamic *StoryGame* format involving a character following a prepared script with user input on decisions would appeal more to school children for a reading-based application.

#### 3.1 StoryMaker

The *StoryMaker* application, written in Java and XML using Android Studio and Android SDK tools, follows the format of a digital picture book and focuses on enabling users to create and tell their own stories. *StoryMaker* relies heavily on established correlations between good readers and good writers, as well as poor readers and poor writers [19]. *StoryMaker* allows young users to create a picture book page-by-page, including text in any language, as well as engaging backdrops incorporating familiar Nal'ibali characters. The pages/storyboards are collected to form a story that may be saved, shared with friends and read again.

*StoryMaker* has a simple creation screen, where the user can either pick backgrounds from a number of familiar scenes or create their own background using the device's camera. The user can then add characters from the Nal'ibali supplement, which may be placed anywhere in the scene via dragging and dropping. Finally, text can be added and placed where desired.

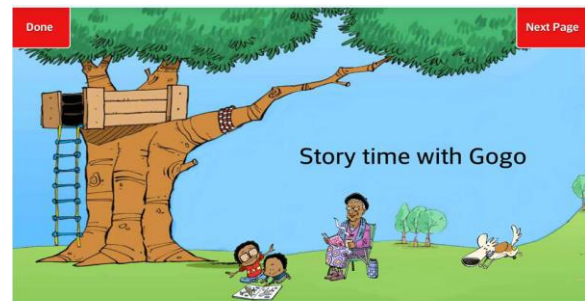
*StoryMaker* is a simple, highly flexible application that is intended to inspire creativity in the user interacting with it. In making backdrops, adding text and arranging characters, a child can express a story in a highly specific, personalized form. With this ability to personalize a story, the hope is that the user will become immersed in their story and, therefore, more interested in telling it. In addition, the act of sharing stories within a group should motivate reading, collaboration and competition between members of the group and, hence, result in increased enthusiasm for the application.

*StoryMaker* also allows teachers to curate their own content in order to teach reading in a classroom setting that does not involve books and hence facilitates dynamic storytelling.

#### 3.2 StoryGame

In contrast to *StoryMaker*, the *StoryGame* prototype application follows a less traditional gamification approach to story telling. *StoryMaker* follows the principles that educational games should keep game controls as simple as possible, to lower the point of entry for users, and that game content should be engaging and relate directly to the skill or content being taught.

*StoryGame* is a side-scrolling game. It was implemented in Javascript using the Unity Game Engine. The user guides a character through a scene to unfold a story. As the user moves the character through the game environment, the story appears, sentence by sentence, at the bottom of the screen. In order to progress through the tale, the user has to complete a number of word challenges in a second language, which aim to improve the



(a) StoryMaker



(b) StoryGame

**Figure 1. Screenshots of the (a) *StoryMaker* and (b) *StoryGame* mobile applications developed to encourage reading in children.**

user's vocabulary. The word challenges take the form of spells which game character casts in order to overcome environmental challenges.

The *StoryGame* prototype supports a single language combination - an English story with Afrikaans vocabulary to learn - and a single level of the game. Once the user reaches the end of the story, the game finishes.

*StoryGame* implements Keller's ARCS Model of Motivational Design [20] in order to motivate children to read. This model identifies four strategies (**A**ttention, **R**elevance, **C**onfidence, **S**atisfaction) that are combined to produce motivation in users. Attention refers to strategies that are used to arouse and sustain interest. In *StoryGame*, this is achieved with a combination of an engaging story and the user's direct control of the movement of the game character through the game environment. Relevance strategies link the game to learner's needs and interests, while confidence strategies help the users develop a positive expectation for successful achievement. This is fostered in *StoryGame* by the vocabulary-learning questions that appear at regular intervals. Satisfaction is achieved through points awarded for correctly answered questions.

These strategies combine to form flow in the game. The game environment is merged with the story which the user reads as they play through the game. The spell system incorporates elements of play and endogenous fantasy in the process of learning new words. These elements in turn facilitate immersion and reflection on the part of the user.

## 4. EVALUATION

The *StoryMaker* and *StoryGame* applications were tested with the help of an existing Nal'ibali reading club based in a school in Kayelitsha, Cape Town South Africa. This evaluation aimed to establish whether the children's interest in reading was increased following exposure to interactive story-telling. In addition, we wished to establish which application design the children preferred.

### 4.1 Experiment Design

The evaluation followed a reversal design, and incorporated both quantitative and qualitative statistical analysis. A short questionnaire was used to evaluate the *StoryMaker* and *StoryGame* applications independently of each other, and a comparison task allowed the two applications to be compared.

#### 4.1.1 Questionnaire.

The questionnaire design was based on the questionnaire used in Sim, McFarlane and Read [21]. Our questionnaire comprises two Likert Scale questions:

- How much fun did you have playing the game?
  - Lots of fun
  - Fun
  - It won't be bad
  - Not much fun
  - No fun at all
- If you could, how much time would you spend playing the game?
  - All the time I could
  - A lot of time
  - Every now and then
  - almost no time
  - No time

and three open ended questions:

- What did you like about the game?

- What did you not like about the game?
- If you could change anything about the game, what would you change? Mention any things that you would add into the game, or take out of it.

The Likert Scale was selected for its flexibility in quantifying responses. Emoticons were associated with the text options for the questions, to provide non-linguistic explanations of the questions for the children. The appropriateness of the language used in the open-ended questions was evaluated by examining the responses given during a pilot study. These responses indicated no need to change the phrasing of the questions.

#### 4.1.2 Comparison Task

The comparison task consisted of icons representing the two applications, which the participants were asked to cut out and paste below the heading which they felt described the application best. The headings were:

- Most fun/Least fun
- Best for education/Worst for education
- Makes me want to read/Doesn't make me want to read
- Easiest to play with/Hardest to play with
- This is the game my teacher would ask us to play
- This is the game I would want to play.

The validity of the comparison task was evaluated by examining the participant's ability to complete it unaided in a pilot study.

## 4.2 Procedure

The evaluation of the *StoryMaker* and *StoryGame* applications comprised two stages: a pilot study, which established the validity and reliability of the materials and testing procedure, and a main study.

Nal'ibali, the NGO for whom the apps were developed, offered one of their reading groups for our study. There were forty black school children in the reading group, from Kukhanyile Primary in Khayelitsha, Cape Town. Half of the children in the reading group were randomly assigned to the pilot study, and half to the main study. The children, who were all between the ages of 10 and 14 years, each used the applications for 10 minutes per application. Their opinions and impressions of the applications were recorded via the set of questionnaires. All children were not native English speakers, but regarded English as their first additional language.

#### 4.2.1 Pilot Study

In the pilot study, twenty participants assessed the applications in each session. First, one group of ten assessed *StoryMaker* and another group of ten assessed *StoryGame*. Each group was allowed to play with these apps for fifteen minutes before completing a questionnaire. The groups then swapped devices, and hence games, and repeated this procedure. To conclude the process, participants performed a comparison task. Due to a shortage of similar devices, *StoryMaker* was presented on a tablet, and *StoryGame* was presented on a smartphone.

#### 4.2.2 Main Study

The chief change in procedure between the pilot and main study was a reduction in the size of groups. Instead of one group of twenty in one session, four groups of five were used across two sessions in the main study. This was done in order to manage the excited children more effectively.

In addition, the main study used only one tablet device. This prevented any bias that may have arisen from the use of a different device when playing a different game. Swapping the mobile devices also lead to situations where it was possible for devices to be stolen. The following guidelines for running a session were established after conducting the pilot study:

- 1) Work stations should be set up prior to the participants entering the room where sessions are being held.
- 2) Participants should not be allowed to leave the room while sessions are being run, unless all devices are accounted for.
- 3) No one not participating in the study should be allowed to enter the room while sessions are being run.
- 4) It is extremely valuable to have an adult present with whom the participants are familiar.
- 5) It is necessary to physically demonstrate the apps, as language barriers can mean that a participants will say they understand how to play even when they don't.
- 6) Response forms must be checked for completeness.

The pilot study confirmed that the questionnaire design was well-suited to the participants' linguistic abilities.

In the main study, two groups were tested in the first session. In this session, the groups were presented with the StoryGame app first. In the second group, the order was switched. This counterbalanced any effect that the order of presentation may have had on the results. The rest of the session was run following the same procedure as the pilot study.

#### 4.2.3 Devices

Ten Samsung Galaxy Fame Lites phones, four Nexus 7 and six Samsung Galaxy Note tablets were used for the pilot studies. After the pilot study, we decided to exclude the smartphones from the main study phase due to security issues: the size of the tablets make them more easily securable. One Nexus and one Samsung tablet were used for the main study.

#### 4.2.4 Ethical Clearance

As per the regulations of the Science Faculty at UCT, an application for ethical approval was submitted to the Faculty of Science Research Ethics Committee. The application detailed the above methodology and precautions. Approval was granted on 5 August 2014. Queries regarding the process can be submitted to Dr Richard C Hill, Chair of the committee, at [richard.hill@uct.ac.za](mailto:richard.hill@uct.ac.za)

## 5. RESULTS

Children's evaluations are by their nature subjective. However, as the point of the *StoryMaker* and *StoryGame* prototype applications is to encourage children to read, their opinions and reported enjoyment are of both interest and importance. During two sessions, the children evaluated the two applications independently according to the questions listed in Section 4.1.1. Both games were enthusiastically received and the evaluations for the two games are very similar: both rank highly with the children on "fun" and "time", with no negative evaluations received (Table 1).

**Table 1. Children's evaluation of *StoryMaker* and *StoryGame***

		$\bar{X}$	$\sigma_x$	Min	Max
StoryGame	Fun	4.8	0.41	4	5

	Time	4.75	0.44	4	5
StoryMaker	Fun	4.7	0.6	3	5
	Time	4.75	0.4	4	5

$\bar{X}$  = Mean  $\sigma_x$  = Standard Deviation

Fun = Fun rating Time = Time spent playing rating

*StoryGame* was ranked as slightly more entertaining than *StoryMaker*, with a mean of 4.8 ("Lots of fun") and a smaller standard deviation. The standard deviations for 'fun' ratings show more variation in the ratings of *StoryMaker* over *StoryGame* – 0.6 versus 0.41. The ratings for the amount of time the participants predicted that they would spend playing the games are equivalent, with the differences in standard deviations insignificant. This level of enthusiasm for the games is encouraging, but may be a result of the novelty and excitement around the testing scenario. Longitudinal studies are needed to establish whether this level of enthusiasm will endure.

To establish which aspects of the applications the children liked and did not like, we probed their more qualitative comments. For *StoryMaker*, the children reported that they liked the instructions provided to teach them how to play the game. They enjoyed the freedom of being able to create their own story and the familiar characters from Nal'ibali stories. They also enjoyed using the camera to take 'selfies' with friends or pictures of other personal items and include them in their story. However, some users found it difficult to play *StoryMaker*, as they were unfamiliar with tablet controls. Participants suggested adding in more characters, and more variety in the characters' appearances – such as different outfits. They made similar suggestions for the backgrounds of the stories.

For *StoryGame*, the children enjoyed the interaction between the story and the game. They enjoyed the setting and the way they were able to learn new words in a new language by learning 'spells'. They found it easy to play the game. The chief issue participants raised with *StoryGame* was that it ended too quickly. Some users suggested adding more characters or different stories. This was to be expected, as *StoryGame* is merely a prototype of the game design, and not a complete application. Some participants found certain words were too difficult to read and would prefer the use of simpler language. Others did not enjoy aspects of the story and suggested changing the setting or characters.

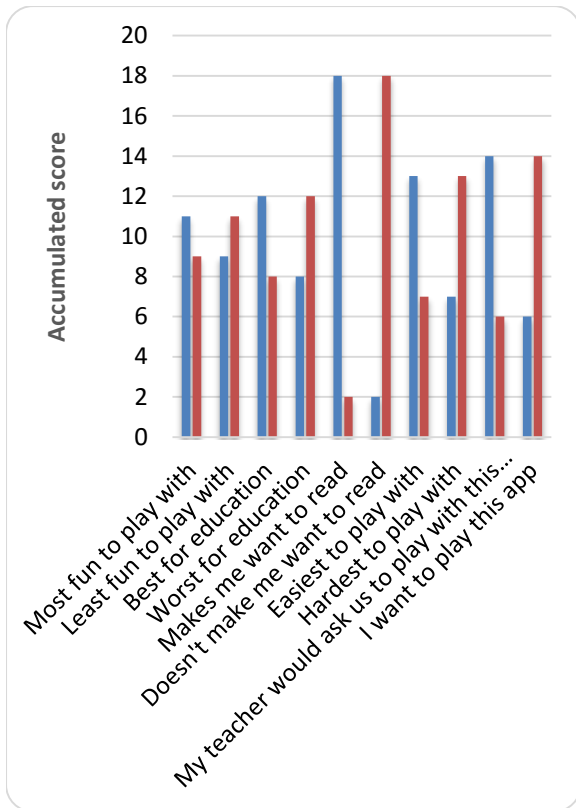
### 5.1 Comparison of *StoryMaker* and *StoryGame*

The bar chart in Figure 2 shows that the children found both of the applications to be equally entertaining ("Most fun to play with"/"Least fun to play with"). The biggest difference is in the "Makes me want to read"/"Doesn't make me want to read" category: the children overwhelmingly ranked the *StoryGame* application as the best method for encouraging reading. It was also considered the easiest to use, which is unsurprising, as more user interaction and decision is required by the *StoryMaker* application and some of the children reported that they were unfamiliar with the tablet device controls, which made it difficult for them to play the game. Therefore the controls in *StoryGame*, which consisted of merely left and right holds to move in those respective directions, and double finger touch to jump, were well-



suitable to the skill levels of the participants. *StoryMaker*, on the other hand, involved controls that required a basic knowledge of tablet controls, such as swipe actions.

Perhaps the most surprising result is that, despite the children's assertion that *StoryGame* is the best at encouraging reading, and somewhat easier to use, the *StoryMaker* application is the one they would choose to play ("I want to play with this app"). They



**Figure 2. Cumulative comparison scores for *StoryMaker* (red) and *StoryGame* (blue) across 20 children surveyed.**

also unfaithfully assumed the teacher would want them to play the opposite application to the one which they would prefer to play!

## 6. CONCLUSIONS AND FUTURE WORK

We found that the children enjoyed interacting both the *StoryMaker* and the *StoryGame* applications. There was no clear winner between the two alternative prototype designs: on average the children felt that the game-based *StoryGame* application would encourage reading more, but they would prefer to interact with creative *StoryMaker* application. These interesting contrasting assertions warrant further testing, with larger sample populations over longer periods of time.

Further development and testing of both prototypes can address other questions as well, such as whether inclusion of a story to read or questions to expand a child's vocabulary in a game will motivate a child to read. Similarly, further research can establish whether simpler controls, or the introduction of a tutorial at the beginning of a game, will make it easier for a child to play.

Nevertheless, the clear apparent enthusiasm of the children for both the applications certainly shows that it is worth continuing to develop these tablet applications to establish whether they will

encourage reading over the long term. Although we did not test whether the applications actually improve reading, it is well accepted that children who enjoy reading, read more and read better, which is an outcome much to be desired.

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