Virtual San Storytelling for Children: Content vs. Experience

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Abstract

This paper describes the development of a Virtual Environment (VE) for telling a traditional San story. The San are an indigenous hunter-gatherer people of southern Africa whose traditional lifestyle has become almost extinct. We present a study which gauges the effectiveness of a San storytelling VE with high-school students. We defined an effective cultural storytelling experience as one in which the story is understood and enjoyed. We explored the possibility of fostering an interest in the story's cultural context. We drew from a number of disciplines in this paper: archeology, film and VE authoring for the creation of our VE; educational theory and psychology research principles in our experimental methodology. In our study we evaluated the effectiveness of a storytelling VE in comparison to reading a story as text. We considered comprehension of the story, the amount of subsequent interest shown in the San culture and the level of enjoyment, boredom and confusion. We found that comprehension of the story was significantly higher for the text group than for the Virtual Reality (VR) group (F(1)=23.54; p<0.0001). We found that interest in the San and desire to find out more about the San was significantly higher for the VR group (F(1)=5.639; p<0.02). Also enjoyment was significantly higher for those who experienced the story in the VE (F(1)=17.67; p<0.001). Boredom (F(1)=7.44; p<0.009) and confusion (F(1)=15.54; p<0.001) in the story were significantly higher for the text group. We conclude that there is a trade-off between conveying the story content and providing the kind of experience that is fun and generates an interest in the story's cultural context.

Categories and Subject Descriptors (according to ACM CCS): J.m. [Computer Applications]: Miscellaneous

1. Introduction

Virtual Reality (VR) has great potential as a technology with social impact; one of the best explored prospects is its capability as a new medium for cultural exhibits and digital storytelling[GCR01, JLC*02, BLWB03, BvDE*99]. VR has shown its ability to produce compelling and accessible displays and its promise as a keeper of history. This has great significance for preserving fragile cultures. However this application of VR has not received much attention in Africa.

This paper describes the development of a Virtual Environment (VE) for telling a traditional San story and presents a study which gauges this VE's effectiveness with high-school students. We focus on investigating VR's ability to convey cultural heritage, in particular oral storytelling, in a comprehensible and interesting way. In Section 2, background information is presented; Sections 3 and 4 describe our approach and our VE respectively. In Section 5 the study is outlined, results are presented in Section 6 and discussed in Section 7. Our conclusion is presented in Section 8.

2. Background

2.1. The San

The San (also known as "Bushmen") are an indigenous hunter-gatherer people of southern Africa. They are considered amongst the earliest human inhabitants of southern Africa, with a recognizable culture dating back over 20 000 years[Par02]. Since the start of colonisation in the late 1400's, San populations have decreased dramatically and their hunter-gatherer lifestyle has become almost extinct[SMGB00]. Recognition and preservation of San culture is essential lest this fascinating early African culture be lost.

Parkington [Par02] shows how important preserved stories are as records of San culture. The Bleek and Lloyd collection at the University of Cape Town is one of the most extensive archives of San folklore; it is a meticulous recording of the stories told by the last traditional San in Cape Town, South Africa during the late nineteenth century of [Par02, LW00].

Records such as these show that the San people have an extensive tradition of oral storytelling. In San culture, telling stories is a fundamental part of daily life. Storytellers are highly respected as it is through stories that their culture is passed on to their children[Par02]. In most cultures, stories are used to explain the world and in the San culture it is no different[Mal92]. This is evident in creation myths: stories which explain how the world and its most basic elements came to be.

2.2. Cultural Heritage, Storytelling and VR

In their review of research challenges and opportunities in information technology for 2010, Brown *et. al.* [BvDE*99] suggest cultural heritage as one of three main application domains for human-centered computing and VE's. So far, VR has been used to create a number of educational cultural experiences. Gaitatzes *et. al.* [GCR01] describe virtual reconstructions of the ancient city of Miletus and the Temple of Zeus in Olympia. Virtual Harlem acts as a record of the Harlem Renaissance during the 1920's and 1930's [JLC*02].

The VE and study presented in this paper is based upon the work of Brown *et. al.* [BLWB03] on virtual San storytelling. This paper focuses on investigating VR's ability to convey cultural heritage, in particular oral storytelling, in a comprehensible and interesting way.

3. Current Approach

We defined an effective storytelling experience to be one where the story is understood and enjoyed. We wished to explore the possibility that an interest in San stories and culture as a whole might be generated by a storytelling experience. We examined the extent to which virtual storytelling could achieve these objectives in comparison with a more common means of storytelling, namely reading a text. Today, San folklore is almost exclusively accessible through texts such as the Bleek and Lloyd collection mentioned earlier. But these stories were always spoken and such texts were transcribed almost exactly as the San told them [LW00]. It was hoped that presenting the San stories orally, using a San storyteller in a VE would capture something of their original, performative spirit. Furthermore, in attempting to convey a kind story with which users are likely to be unfamiliar, it is important to seek ways in which to make the experience more accessible and interesting. We believe that an important purpose of preserving cultural heritage is to impart an understanding and awareness of a culture and ensure that such heritage is not forgotten.

4. Virtual San Storytelling

In order to conduct our study we created a VE in which users were able to hear a traditional San story. This was set in a cave at dusk, with a San gathering sitting around a fire,

shown in Figure 1. The cave was modelled on those found in the Cederberg mountains of the Western Cape, South Africa. The San people once inhabited this region and it is one of the richest regions of San rock art[Par02]. Digital images of Cederberg caves were used to texture the virtual cave. Photographs were used to texture existing San rock paintings onto the cave wall[Par02, Bas01]. The rock paintings were chosen such that they related to the San story. In their San storytelling VE, Brown *et.al* [BLWB03] found that including rock paintings in this way increased users' involvement in the story. The San gathering consists of an adult man, two children and an elder woman, who acts as the storyteller. The San gathering in the cave with rock paintings are shown in Figure 2.
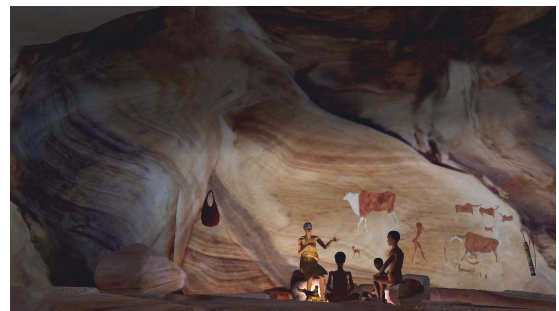

Figure 1: *The cave and San gathering seen from a distance.*

Figure 2: *The San gathering in the cave, the San rock paintings are visible on the cave wall. Here, the San man is inviting the user to join the group.*

Particular attention was paid to creating characters with the clothing and physique of the San people. Photographs of the San were used by an artist to create detailed sketches of the San characters. These sketches were then used as refer-

ence in the modelling of the San characters. One of the reference sketches for the San storyteller is shown in Figure 3
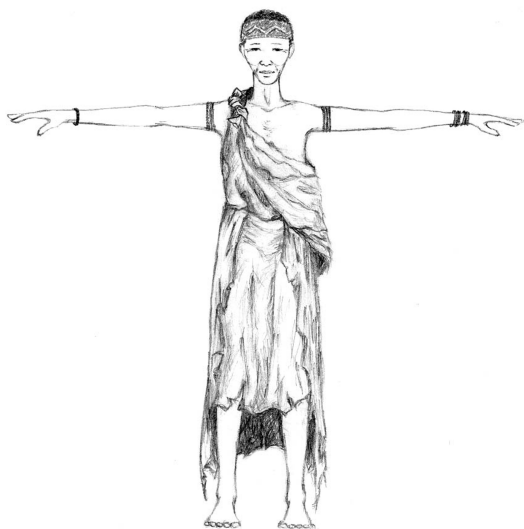

Figure 3: *An example of a reference sketch used to model the San storyteller.*

In the VE, as the user walks toward the gathering, the San man stands up and looks in the direction of the user. During this time a simple African music track plays in the background to set the scene. We also recorded and used outdoor ambient sounds such as wind blowing and crickets chirping to create the outdoor soundscape. When the user has almost reached the gathering, the music fades and the San man invites the user to move closer to the gathering. However, if the user takes longer than ten seconds to walk toward the gathering, the San man also offers this encouragement. Figure 2 shows the San man inviting the user to come closer after which the storyteller speaks:

> I was just about to tell a story, the one about how the Mantis made the Eland, please sit down with us and listen.

The storyteller then begins to tell the story, during this time the user is free to explore the cave area. The user can examine the fire, rock paintings and other objects such a grinding stone and a bag and quiver hanging from wooden pegs on the cave wall. These objects were created and placed in accordance with San reference material and the advice of archeologist, Prof. John Parkington. The San gathering react during the storytelling by exclaiming, gesturing and moving their heads. The storyteller character is also animated throughout the story narration. The voice of the storyteller was provided by a local voice-over actress. During this voice recording her natural hand gestures were video taped. This footage served as the basis for the storyteller's animations.

Figure 4 shows the storyteller narrating the story. When the story is finished the lights in the VE gradually fade to black to indicate the end of the virtual storytelling experience.
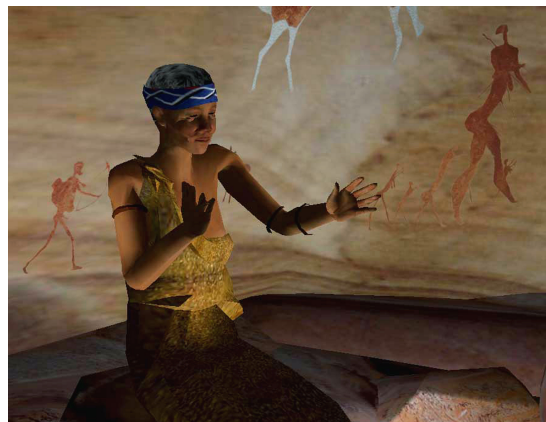

Figure 4: *The San storyteller during story narration. The storyteller's animations were based on the hand gestures of the voice-over actress who provided the voice for the storyteller.*

The story told in the environment was taken from a Bleek & Lloyd collection of San folklore[LBB23]. This collection contains two versions of a story about how the mantis created the eland and the moon. In San culture, Kaggen, the mantis, is considered as the magical and mischievous creator of the animals. The eland is the most revered of hunted animals to the San, since it is considered to be Kaggen's favourite[LBB23]. The two versions of the story were combined and slightly adapted to form the story text used in the VE.

Our design and implementation drew from a number of disciplines in order to produce a complete and authentic San storytelling experience. We consulted an archaeologist, Prof. John Parkington, to evaluate the authenticity of our environment. His input informed the creation of our cave setting, the San characters and the compilation of our story text. Before creating our VE, a detailed storyboard was drawn up and used extensively during the VE implementation. For guidance on the elements that should be included in an all-encompassing storyboard, techniques used in planning films were explored. Film storyboarding techniques were examined and adapted to create a VE storyboard.

The VE was implemented using our VE authoring tool called CAVEAT (Collaborative African Virtual Environment Authoring Toolkit). This tool is a scripting engine and user interface built on top of a commercial games engine; it allows for high-level creation of VE's.

5. The Study

The aim of this study was to examine the difference between listening to a story in a VE and reading that same story.

5.1. Variables

The independent variable in this study was:

- *Storytelling Medium (SM):* This variable has two levels, and is manipulated by using either text (T) or virtual reality (VR) to convey the San story.

   The dependent variables in this study were:

- *Comprehension (COM):* This variable is a measure of the understanding of story.
- *Interest (INT):* This variable is a measure of interest in the story's context (in this case the San people and storytelling).
- *Enjoyment (ENJ):* This variable is a measure of enjoyment of the storytelling experience.

5.2. Sample

A sample of 44 high-school children aged 15 to 17 were used. Twenty-two children experienced the virtual storytelling and 64 experienced story text. Questionnaire responses from the text group were collected randomly to match the number of VR subjects for comparative analysis.

5.3. Experimental Procedure

The study was conducted with three different classes during school hours. Eight students were randomly chosen from each class to form the VR group who would hear the San story in the VE. The rest of the class formed the text group, who read the story. Consequently, the text group was larger than the VR group since we were only able to accommodate a limited number of participants in the VR group. The students were informed that they would be taking part in a study on San storytelling but were given no further information regarding what they would experience during the study until the VR and text groups were separated. This way, we hoped to decrease the chance of the students forming expectations of their own or of each other's forthcoming experiences.

A quiet experimental room was set up with four computers. Here, four members of the VR group were able to experience the storytelling VE at one time, each at a computer. First they were informed that they would be experiencing a traditional San story in a VE. The use of keyboard and mouse for navigation were described. A training VE which reiterated the navigation controls in text was provided. Participants practiced navigating the training VE until they felt comfortable with the controls. Thereafter, they were asked to each put on the provided headphones. The experimental room was darkened and the students experienced the San storytelling VE under the supervision of an experimenter. The VR group then completed two questionnaires.

The text group were each given the San story in text and asked to read the story once and then turn the text face down on their desks. When everyone had finished reading, the texts were collected, and each participant completed two questionnaires. Both the VR and text groups were not not informed of the questionnaire before their storytelling experience to ensure that any comprehension attained would be incidental, rather than intentional.

5.4. Questionnaires

A particular challenge in this study was that of obtaining questionnaires to measure the dependant variables. This was since the variables we wished to examine were relatively unique to our study. Since there were no pre-existing questionnaires for measurement, we created two questionnaires. These are detailed below in Sections 5.4.1 and 5.4.2.

5.4.1. Comprehension

We required a comprehension measure that was reliable and an appropriate measure for both reading and listening comprehension. This was since our subjects would either be reading or listening to the story. Although there were no pre-existing questionnaires that would test comprehension for our particular San story, educational research and theory has a long history of comprehension measures from which we were able to draw[SP98]. A number of techniques for creating comprehension tests were examined and four were ultimately employed:

Cloze: In a cloze test, sentences from the story text are presented with every fifth word deleted; participants are required to fill in the missing words.[SP98] We modified this technique slightly and used one cloze sentence in our comprehension questionnaire:

> The story was about how the Mantis made the _____ and the _____.

This question derives from the title of the San story: 'How the Mantis Made the Eland and the Moon'. We hoped that answers to this question would give an indication of whether participants had grasped, at a very basic level, what the San story had been about.

Sequence Test: This test is a measure of how well subjects understood the narrative flow of events. Each question presents a list of events from the story. Subjects answer an accompanying question by choosing one of the events in the list[SP98]. Ricci and Beal [RB02] made use of a sequence test variation in their investigation of children's story comprehension. Five sequence questions were created for the present study. Here is an example of one:

1. What happened first in the story?

a. The mantis went to find some honey.
b. The mantis rubbed sweet honey into the Elands ribs.
c. The mantis picked up a piece of Kwammang-a's shoe and soaked it in the water by the reeds.

Sentence Verification Technique (SVT): The SVT is a means of constructing a comprehension test using sentences from the story text. It works by deriving four sentences from a sentence in the story text:

1. *Original:* The sentence as it appeared in the story.
2. *Paraphrase:* Constructed by changing as many words as possible in the original sentence without altering the meaning.
3. *Meaning Change:* Constructed by changing one or two words in the original sentence such that the meaning is changed.
4. *Distractor:* Appears similar to the original sentence and fits in with the story content, but is unrelated in meaning to any of the story events.

Subjects are presented with the sentences and required to state for each whether they were true or false according to the story. The original and paraphrase sentences are always true, whereas the meaning change and distractor sentences are always false[Roy01]. The SVT is one of the few comprehension tests considered applicable for measuring both reading and listening comprehension[CF91]. Royer [Roy01] states that this is because it examines story comprehension rather than sentence comprehension. Furthermore, numerous studies have proven the validity and reliability of the SVT[Roy01].

We created three sets of the above kinds of sentences using the SVT. The resultant twelve sentences were presented in their sets of four on the questionnaire but the ordering of sentence types was randomised to ensure that participants would be unable to detect a consistent answering pattern. For instance if the sentences were always placed in the order specified in the explanation above, participants might notice that the order of answers are always true, true, false, false. They might then use this perceived pattern in answering rather than their own understanding of the story.

Specific Questions: In their study of children's story comprehension Ricci & Beal [RB02] used specific questions to test children's ability to retain explicit story information and make inferences using story information. Our study presented specific questions in a similar way by asking two types of specific questions:

1. *Fact Questions:* These questions tested participants recall of information explicitly presented in the story.
2. *Inference Questions:* These questions required participants to use story information to make inferences about the story.

We included three questions of each type and considered the fact and inference questions separately during analysis.

5.4.2. Interest and Enjoyment

We devised a questionnaire for measuring interest in the San culture and enjoyment of the storytelling experience itself. This questionnaire consisted of three subscales:

1. *Interest Baseline:* consisted of two parts:
   - *tIB:* a measure of tendency to be interested in the cultures of South Africa and folklore.
   - *sIB:* a measure of existing awareness of the San and their folklore.

2. *Interest:* a measure of the level of interest in the San and desire to find out more about the San.
3. *Enjoyment:* a measure of enjoyment of the San story. This included questions on how confusing and boring participants found the story.

All these questions were presented as statements and participants were asked to rate how much the statement applied to them on a seven-point Likert-type scale. This questionnaire consisted of four interest baseline questions, nine interest questions and four enjoyment questions. The interest baseline questions were included as a means of identifying subjects who would be more likely to express an interest in the San. By taking this into account we were able to conduct a more complete analysis of how much interest arose as a result of the storytelling experience, as opposed to a tendency to show interest. The enjoyment component of this questionnaire contained two questions asking children to rate their level of enjoyment of the San story. We included two questions on how confusing and boring the San story was since these would have been likely to detract from enjoyment. A low level of confusion or boredom was measured as adding to the enjoyment of the story.

6. Results

6.1. Psychometric Analysis

Before beginning analysis of variables, we tested the reliability of our questionnaires. This was done by performing correlations between questionnaire items to determine their concurrent validity. We also calculated Cronbach's alpha coefficient or Kuder-Richardson 20 (KR20) value where appropriate. These both measure the extent to which the items in a scale measure the same factor[AU91, Cro90]. A value of 0.8 or higher (out of a range of 0 to 1) for Cronbach's alpha coefficient or KR20 is considered acceptable[AU91].

Our comprehension questionnaire comprised of the following five subscales:

1. Cloze (Ccloze)
2. Sequence Test (Cseq)
3. SVT Test (Csvt)
4. Fact Questions (Cfact)
5. Inference Questions (Cinf)

Almost half of our subjects answered the Cinf items completely correctly while the other half answered one Cinf item incorrectly. We therefore excluded Cinf from further analysis since it contained too little variance. We performed correlations between the scores obtained for the remaining subscales and discovered the following significant correlations:

- Ccloze and Cseq (r=0.38, p<0.05)
- Ccloze and Csvt (r=0.45, p<0.05)
- Cseq and Csvt (r=0.35, p<0.05)
- Cfact and Cseq (r=0.55, p<0.05)

The first three comprehension subscales correlated with each other indicating concurrent validity between them. We therefore decided to construct our overall comprehension measure as a sum of these three subscales. Therefore our comprehension questionnaire consisted of dichotomous rather than continuous scales since the result for each item was either correct or incorrect. In this case it is not appropriate to use Cronbach's alpha but rather the KR20 value[Gre91]. Ccloze consisted of too few items for a KR20 computation. For Cseq (KR20=0.626, n=44) and Csvt (KR20=0.481, n=44) the KR20 value was not sufficiently h igh to claim agreement between items. It must be noted that, in order to keep questionnaires a reasonable length, we were unable to set a large number of items for each comprehension subscale. A paucity of items is a main contributor to decreased reliability in KR20 formula.

The interest baseline subscale consisted of two parts: tIB and sIB (see Section 5.4.2). Both contained too few items for a Cronbach calculation. We did, however, perform correlations and found that the two items measuring sIB correlated significantly (r=0.44, p<0.05), whereas the two items measuring tIB did not. This result was not unexpected since the first tIB item enquired into a tendency to enjoy mythology and the second into a tendency to be interested in indigenous cultures. Thus they each tapped into different tendencies. However together they were useful in interpreting our interest variable (see Section 6.4).

All the interest items correlated significantly indicating concurrent validity in this subscale. Cronbach's alpha coefficient was sufficiently high (α=0.917, n=44) to conclude that the items agreed on the measurement of interest. We further wished to ensure that experimenter bias had not affected the interest scores. In other words we wanted to test if the children had answered the interest questions according to personal opinion or according to a perception of experimenter expectation. Analysis of the frequency distribution for the answers to each interest item showed that the children were as likely to produce answers pleasing to the experimenter as displeasing answers. This implies that they answered the interest questions according to personal opinion as hoped.

Enjoyment was measured using four questions, two of which looked at enjoyment and two of which looked at confusion and boredom. We did not wish to simply assume a lack of confusion or boredom implied a higher level of enjoyment. We therefore created the following variables related to enjoyment:

- *Enjoyment (ENJ):* extent to which the story experience was enjoyable
- *Confusion (CON):* reported level of confusion in the story
- *Boredom (BOR):* reported level of boredom in the story
- *Broad Enjoyment (BroadENJ):* includes ENJ as above and low levels of CON and BOR

We found significant negative correlations between ENJ and CON (r=-0.38, p<0.05) and between ENJ and BOR (r=-0.83, p<0.05). This implies that low levels of confusion and boredom were related to high levels of enjoyment and vice versa. Since BroadENJ considered low levels of confusion and boredom, this implies that BroadENJ is a valid, more extensive measure than ENJ. Furthermore the Cronbach's alpha coeffcient (α=0.849, n=44) for BroadEnj indicated that its items measured the same or related factors. We also found a significant correlation between the two questions for enjoyment (r=0.78,p<0.05), suggesting concurrent validity between them.

6.2. Correlations between the Dependent Variables

We calculated correlations between all our dependent variables and found that, with the exception of comprehension, they were all related to each other. INT correlated significantly with ENJ (r=0.69, p<0.05) and BroadENJ (r=0.72, p<0.05). INT correlated negatively with CON (r=-0.47, p<0.05) and BOR (r=-0.63, p<0.05). CON and BOR also correlated significantly with each other (r=0.48, p<0.05).

6.3. The Effect of Storytelling Medium on Comprehension

A one-way ANOVA was performed to determine the effect that reading the San story had on comprehension in comparison to experiencing it in the VE. We found that reading the story text produced significantly higher comprehension (F(1)=23.54; p<0.0001). This effect is shown in Figure 5.

6.4. The Effect of Storytelling Medium on Interest

A different situation was found regarding the interest shown in finding out more about the San. A one-way ANOVA showed that the virtual storytelling group exhibited a significantly higher degree of interest than the text group (F(1)=5.639; p<0.02). This effect is shown in Figure 6

We wanted more of an idea of the effect the storytelling medium had on subsequent interest in the San. Therefore, we also looked at the interest baseline (IB) as predictor of interest. We built a general linear model to test the tendency to show interest (tIB), existing knowledge of the San (sIB) and storytelling medium (SM) as predictors of INT. The results of this model can be seen in Table 1. Here we see that
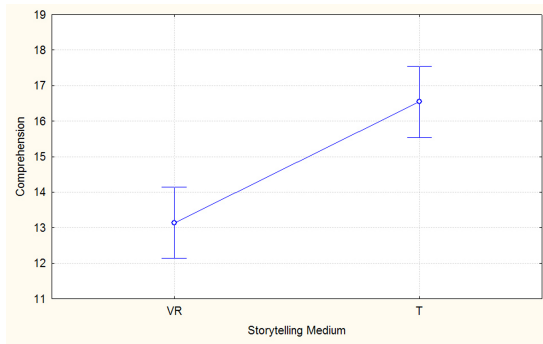
Figure 5: *Means plot of the effect of Storytelling Medium on Comprehension. VR refers to the virtual storytelling group and T refers to the text storytelling group. $F(1.42)=23.545$, $p=.00002$*
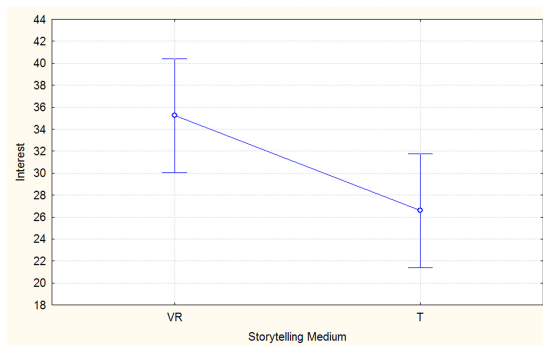

Figure 6: *Means plot of the effect of Storytelling Medium on Interest. VR refers to the virtual storytelling group and T refers to the text storytelling group. $F(1.42)=5.6387$, $p=.02221$*

there are two significant predictors of interest: tIB and SM. We can also see that despite the very high significance of tIB as a predictor, SM still contributed significantly to interest in this study.

Effect	df	F	p
tIB	**1**	**53.98**	**< 0.0001**
sIB	1	0.27	< 0.609
SM	**1**	**7.02**	**< 0.011**

Table 1: *Summary of effects for a general linear model with interest as the dependent variable. Significant effects ($p < 0.05$) are marked in bold.*

6.5. The Effect of Storytelling Medium on Enjoyment, Confusion and Boredom

One-way ANOVA's with both our enjoyment variables revealed a significant increases in ENJ ($F(1)=17.67$; $p<0.001$)and BroadENJ ($F(1)=21.34$; $p<0.001$) for those who experienced the virtual storytelling as opposed to the story text. We also used one-way ANOVA's to investigate the effect of storytelling medium on reported levels of confusion and boredom. We found that both boredom ($F(1)=7.44$; $p<0.009$) and confusion ($F(1)=15.54$; $p<0.001$) was higher for the text group.

7. Discussion

7.1. The Effect of Storytelling Medium on Comprehension

We found that comprehension was significantly higher for the text group than for the VR group. There are a number of possible reasons for this effect. Firstly, although the text group were instructed to read the text only once, we observed that participants would reread parts of the text. Indeed, rereading sentences is a common reading technique[ES85]. We also observed that some children would finish reading the text and, before placing the paper face down on their desks as instructed, would glance over the beginning of the text again. This behaviour may be no more than an attempt to pass time until their next task. But it does mean that subjects in the text group were able to experience parts of the story more than once, whereas the VR group only experienced the entire story once. This was since the text group had the entire story text available to them throughout their storytelling experience in a way that the VR group did not. Those in the VR group had no control over the amount of time in which they experienced the story. The text group, however, were able to pace their reading and determine how much time they had to absorb the story. This coupled with the opportunity of repeated exposure to parts of the story could have increased the text group's chance of achieving higher comprehension.

Secondly, in the VR group, we observed that that some subjects would find a position in the VE from where they could see the storyteller clearly and stay there for the duration of the story. Others explored the cave environment during some or all of the storytelling. Additionally, since we used spatialised sound in the VE, the further away from the cave users wandered, the softer the storyteller's voice became. Therefore, while subjects were always able to hear the story, they were not always paying full attention to it. Furthermore, the text group had only the story content to attend to; in the VE there was also a visual and audio environment. It is thus reasonable to assume that the VR group's attention was not always focused on the story content in the way that the text group's attention was. This would likely have had a negative effect on their comprehension of the story.

Of course we must be careful of conclusions made on the basis of our comprehension measure. While we found that the comprehension subscales had concurrent validity we did not find them to be sufficiently reliable (see Section 6.1). We would like to conduct a further study using a revised comprehension measure that excludes the subscales that were not used in the present analysis, namely Cfact and Cinf. This would allow us to include more items in the Ccloze, Cseq and Csvt subscales, thereby increasing the reliability of our comprehension measure.

7.2. The Effect of Storytelling Medium on Interest

We found that interest was significantly higher for the VR group than for the text group. We could speculate that a more enjoyable experience of the story led to a greater interest, given the correlation between interest and enjoyment (see Section 6.2). Similarly, lower levels of boredom and confusion correlated with interest. However, since these are correlations, we cannot make conclusions regarding causation.

There is an important difference between the virtual storytelling and the story text that might have affected interest. For high-school students, reading a text is a common experience, whereas navigating a cultural VE is, likely not. It may be that presenting the San and their folklore in a novel way made it more interesting than text was able to. Furthermore, using VR allowed us to present, along with the story, a context and setting. Therefore, with VR we presented *more* than just the story text, but also a visual representation of the San people telling stories as they used to in a typical dwelling place. The extra information might have increased the number of things to be interested in during the storytelling experience. Our result certainly supports a hypothesis that the story content on its own was not enough to engender interest in the story's context, but presenting such contextualisation offered a means for generating interest.

7.3. The Effect of Storytelling Medium on Enjoyment, Confusion and Boredom

Enjoyment of the storytelling experience was significantly higher for the VR group than for the text group, while boredom was significantly higher for those who read the text. The reasons for these differences are likely to be similar to those suggested for the VR group's increased interest. Namely, the virtual storytelling as a novel experience and presenting more information than just the story content. Firstly, the novelty of the experience was likely to increase the enjoyment thereof. Secondly, presenting more information than the story text also gave the children more to do and experience in the VE. This would also explain the decreased boredom observed in the VR group. Additionally, the use of a real storyteller as opposed to words on a page might have made the virtual storytelling experience a more personal and appealing one.

Strangely, we found that confusion was significantly higher for those reading the story text. According to our other results, this makes sense since confusion and boredom correlate (see Section 6.2). But, on the other hand it seems contradictory in relation to our finding on comprehension. Intuition would suggest that if one found a story confusing, then comprehension would be more difficult to achieve. Paradoxically, we found that those who read the story text reported significantly higher levels of confusion, yet they also achieved significantly higher comprehension scores!

Interestingly, we also found a zero correlation between comprehension and confusion (r= 0.08). It is possible that, in rating their level of confusion, children were actually reporting how strange the story seemed to them rather than how incomprehensible. If this is the case, then our result that the children reading the text found the story significantly more confusing or strange is important. One could deduce that experiencing the story in a VE with a San gathering made the story content seem less unusual. This would imply that the VE contextualised the San story, which was otherwise perceived as more peculiar, and allowed the children to relate to it more. It may also be that hearing the story allows it to seem more natural. Unlike the text readers, the VR group did not have to grapple with foreign-sounding character names since they are spoken by a San storyteller. Since English is not the original language of these stories, they may appear to have strange grammar or diction. These may seem more natural when heard spoken. Recall that the San stories were mostly transcribed from speech (see Section 2.1) and contained innate rhythms that may not come across as easily when read. Of course, we cannot draw these conclusions confidently from only one question, and an ambiguous one at that. We intend to explore to these notions on the perceived strangeness of the San story in a future study with more extensive measures.

8. Content *vs.* Experience

It is clear from our results that both the tested storytelling media have advantages and disadvantages. In conceptualising the present study, we defined an effective cultural storytelling experience as one where the narrative was conveyed comprehensibly, was enjoyable and possibly fostered an interest in finding out more about the folklore and its context. For the present study we hoped to examine virtual storytelling's ability to achieve these goals in comparison to the most typical means of experiencing San folklore: text.

Our results imply that there is a trade-off between conveying the story content and providing the kind of experience that is fun and generates an interest in the San people. We could classify comprehension as a variable relating to *content* and the interest, enjoyment, confusion and boredom as variables relating to the *experience* of the story. The study we have presented indicates that success in both content and experience do not come hand-in-hand. This seems to lead

us to a choice: which of these two should be a more important goal in the case of effective cultural preservation? If the story content is understood and retained, the experience is not necessarily enjoyable and does not necessarily prompt further exploration of the context. Is there much point in such a once-off, possibly boring story experience? While our VR users did not grasp and retain the story content as fully, they had what we would term a more effective experience of the story. Indeed, if we can achieve an interest in the San and their folklore, then there is an increased likelihood that these users will be more open to finding out about the San. They may even go on to read more of the San folklore, providing the means for achieving the complement of our goals: conveying of story content. To be fully confident of VR's ability to achieve this, it would be useful to study how it performs when compared with live storytelling or a storytelling video.

If our goal in cultural storytelling is to create a compelling, enduring experience of cultural heritage, then VR may well be a valuable, novel tool for preserving the stories and culture of the San and other indigenous African people.

9. Acknowledgements

References

[AU91]   ANASTASI A., URBINA S.: *Psychological Testing*. NY:Prentice Hall, New York, 1991.

[Bas01]   BASSETT S.: *Rock Paintings of South Africa: Revealing a Legacy*. David Philip Publishers (Pty) Ltd, Claremont, South Africa, 2001.

[BLWB03]   BROWN S., LADEIRA I., WINTERBOTTOM C., BLAKE E.: The effects of mediation in a storytelling virtual environment. In *Virtual Storytelling: Using Virtual Reality Technologies for Storytelling* (2003), Springer-Verlag. Proc. 2nd International Conference ICVS.

[BvDE*99]   BROWN J. R., VAN DAM A., EARNSHAW R., ENCARNACAO J., GUEDJ R., PREECE J., SHNEIDERMAN B., VINCE J.: Human-centered computing, online communities, and virtual environments. *IEEE Computer Graphics and Applications 19*, 6 (November/December 1999), 70–74.

[CF91]   CARLISLE J., FELBINGER L.: Profiles of listening and reading comprehension. *Journal of Educational Research 84*, 6 (1991), 345–354.

[Cro90]   CRONBAH L. J.: *Essentials of Psychological Testing*. NY:Addison Wesley, New York, 1990.

[ES85]   EBO T., STEWART O.: Effective studying from text. *Forum for Reading 16*, 2 (1985), ED 262 – 378.

[GCR01]   GAITATZES A., CHRISTOPOULOS D., ROUSSOU M.: Reviving the past: cultural heritage meets virtual reality. In *Proceedings of the 2001 conference on Virtual reality, archeology, and cultural heritage* (2001), ACM Press, pp. 103–110.

[Gre91]   GREGORY R.: *Psychological Testing: History, Principles and Applications*. MA.: Allyn and Bacon, Boston, 1991.

[JLC*02]   JOHNSON A., LEIGH J., CARTER B., SOSNOSKI J., JONES S.: Virtual harlem. *IEEE Computer Graphics and Applications: Art History and Archaeology 22*, 5 (September/October 2002), 61–67.

[LBB23]   LLOYD L., BLEEK W., BLEEK D.: *The Mantis and his Friends: Bushman folklore*. Maskew Miller, Cape Town, 1923.

[LW00]   LEWIS-WILLIAMS J. (Ed.): *Stories that float from afar*. David Philip Publishers (Pty) Ltd, Cape Town, 2000.

[Mal92]   MALINOWSKI B.: *Magic, Science and Religion and Other Essays*. Prospect Heights, Ill: Waveland Press, Inc., 1992.

[Par02]   PARKINGTON J.: *The Mantis, the Eland and the Hunter*. Creda Communications, Cape Town, 2002.

[RB02]   RICCI C., BEAL C.: The effect of interactive media on children's story memory. *Journal of Educational Psychology 94*, 1 (2002), 138–144.

[Roy01]   ROYER J.: Developing reading and listening comprehension tests based on the sentence verification techinique(svt). *Journal of Adolescent and Adult Literacy 45*, 1 (2001), 30–41.

[SMGB00]   SMITH A., MALHERBE C., GUENTHER M., BERENS P.: *The Bushmen of Southern Africa: A foraging society in transition*. David Philip Publishers (Pty) Ltd, Cape Town and Ohio University Press, Athens, 2000.

[SP98]   SARROUB L., PEARSON P.: Two steps forward three back: The stormy history of reading comprehension assessment. *Clearing House Washington 72*, 1 (1998), 97–105.