Developing a Visualized Cultural Knowledge Transfer Prototype: An In Situ Evaluation in Rural Namibia

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ABSTRACT

Youth in Sub-Saharan Africa suffers from a loss of valuable cultural knowledge, which has been a foundation for the coming generations' survival and cultural self-awareness. By transferring cultural knowledge contexts into 3D visualizations, we prototyped and evaluated a system to bridge the gap between elders and urban youth in Namibia. The findings from the field experiment indicate that designers together with rural elders and children can reach a shared design platform by communicating visually.

Keywords

knowledge transfer, 3D, visualization, rural user evaluation

1. INTRODUCTION

For centuries the mode of teaching and learning in African rural areas has been directly linked with oral presentation of narratives and learning by doing in local villages. This valuable knowledge has been a foundation for the coming generations' survival and cultural self-awareness not only limited to historic reflections, but to prepare the youth for challenges and difficulties in their respective future. Belonging to smaller rural communities with few households every bit of information transferred from generation to generation is not only maintaining spiritual connection to the world around them through rituals, it is crucial to combat and understand livestock diseases. When living remote and without institutionalized medicinal assistance, it is a matter of survival to possess exact knowledge as to where to collect healing herbs for ill family members. Presently in Sub-Saharan countries there are efforts made to teach modern topics to the indigenous youth in schools to prepare them for a demanding world, to increase their digital literacy and to support the development and stability of the country they live in.

To partake in this development, rural village elders from Herero tribes in Namibia send their children to study in schools up to several hundred kilometers away from their homesteads, where they will remain for years and only return on holidays. After graduation, some return to their local villages to reassume an active role in the community populated by mostly illiterate farmers [1] and a majority return after many years in the cities to remotely placed villages with poor sanitation, no grid electricity and a digital divide [2, 3, 6]. The paradox occurs during the children's learning of modern topics, where they miss out on their cultural teaching, which makes it a huge problem for them to understand how to survive and interact in their original traditional communities. The generation of elders, who are the rural knowledge managers in the 'red' [4] villages, is diminishing, which makes the problem immediate and urgent. Valuable knowledge is lost day by day, and future generations could very well suffer from this absence of cultural knowledge, which could generate a new row of problems regarding self-awareness, loss of cultural adaptation and self-worth.

To overcome the difficulties in transferring important indigenous rural knowledge from village elders to urban youth, we try to leap the textual literacy and digital illiteracy gap by visualizing the information as a 3D graphical representation depicting the rural community and important scenarios for transferring cultural knowledge. The scenarios' roles are to complement traditional oral narratives with 3D graphical animations, collected situated video material from previous field trips [21] and virtual village reference points. Visualization of culture and traditions has a history back to the first humans in form of cave paintings, Egyptian hieroglyphs etc. We believe this medium has a lot to offer by using a modernized palette consisting of animations, HCI and hardware -if used appropriately with the given context in mind.

In this first development cycle we document through an in situ discussion in a Herero village in Namibia, how rural elders perceive and reflect upon a prototype, which visualizes their village and selected cultural situations. Secondly, we investigate how the young people, with relatively poor ICT skills, understand and reflect on the proposed system. To avoid a Western design approach, we are focused on the active participation and collaboration of the end users' knowledge, ICT constraints and visions through a community centered design. After presenting related work in this area, we elaborate on the development of the prototype and importance of actively using culture in the design process. Subsequently, the premises for the in situ test are presented, the field trip experiences and observations from the village are reflected upon in order to understand how testing can be complicated in a non-Western cultural context. After concluding our research, we give ideas on how to develop our prototype with the use of cultural metaphors to implement a non-textual based GUI.

2. RELATED WORK

Various projects in Africa have been initiated using tailored software solutions, which – although employed in a different cultural context – have tried to approach the end users by Western design and implementation traditions. The authors in [5] explain

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how they designed a decision making system for solving bush encroachment issues on rangelands in Southern Africa. The implementation was considered successful, but they made crucial mistakes in understanding the end users in the community, who were mostly digitally illiterate. The farmers had basic problems in interacting with the system, having never being taught the functionality of a (from a Western perspective) traditional GUI. Subsequently they did not foresee implementing an agricultural terminology for their system would leave the uneducated farmers confused about basic agricultural knowledge, which they normally understood through tradition, knowledge sharing and intuition. After a complete redesign of the system in user workshops the authors stress the importance of the interest from the community, the trust of the involved and the importance for designers to be willing to allow end users into the process from early on. We believe in order to gain from the community's collective memory, and cultural knowledge, that it is of strong importance to allow the users to partake in developing the system, thus striving for an emic approach rather than through etic observations. If the community can embrace a proposed system, we believe that there are many resources to collect, and in parallel designers could learn and get inspired by the different approaches of doing things. As described in [7], the author emphasizes the importance of using a cultural model and that the designers understand cultural flow in a cross-cultural process. By the opinion of the author the use of a cultural model is not restricted to using it as a 'filter' before an IT solution is made, but to let user values fuse into the process when developing a method, and not only let IT experts lead the implementation. The end users' context is not only important for knowing where to implement, but indeed also how. The IT experts should help facilitate this process and fuse their expertise into the development pipeline.

3. PROTOTYPE

Implementing a system in a cross-cultural setting like the Namibian rural areas and with the purpose of transferring knowledge, will provide obstacles not normally found in the software development process [22]. Findings from earlier prototypes [23] in this research project provided important guidelines about how e.g. textual oriented interfaces proved confusing to the villagers. A Lo-Fi prototype has therefore been developed, which takes these obstacles into account, in order to investigate a solution in bridging the cultural gap through a 3D graphical representation of a Herero village, and investigate whether it can serve as a proof of concept to the village community [8].

3.1 Layers

An information system traditionally consists of the following three layers. Firstly, the context, which is the actual information being available to the user. Secondly, a GUI that provides visualization or textual understanding of how to reach the context. Thirdly, there is an interaction device or method to control the GUI. These layers are normal in the Western world and with many prerequisites attached, which might not be rational demands for the rural Namibian community. In [10] it is argued that cultural heritage usability assumptions can likewise be harmful. Further research showed that the indigenous users are reluctant on using a computer if the interface is heavily text structured as often seen in a Western context [11]. Studies concerning the use of GUIs in rural communities have further shown that identification of cultural icons and visualizations are more logical to illiterate people and should therefore be preferred over textual representations [12, 13]. One obstacle is the general literacy, both digital and written. Subsequently, a GUI containing text and elements like buttons and drop down menus will be counterproductive and in the worst case not used [5]. A GUI is therefore not a part of the prototype in order to make a low friction experience for the community as they observe the presentation of the prototype, but in future prototypes it could be interesting to design control elements for the rural communities and likewise the younger generation in order to allow efficient management of potentially large amounts of data and video.

3.2 3D Visualizations to Bridge the Gap

Previous studies in the community; where this prototype is evaluated, have revealed the need to understand cultural knowledge not only as information, but as knowledge constructed through interactions with other members of the community and the nature surrounding the community [6]. To be able to depict information and relations of knowledge unhinged from temporal and spatial limitations, we therefore seek to approach difficulties in knowledge sharing with a medium which possesses visualizing capabilities and possibilities to incorporate game dynamics. This allows illustrating important contextual aspects like changing seasons, burning fires, growing trees or animated people and animals. Additionally, the prototype is constructed as a platform for placing previously recorded videos on cultural knowledge like herb lore, thus creating a shared space for designers and community members [6]. We focused on high fidelity graphical resemblance, due to the consideration that if the community members are able to understand the concept of their village in 3D, we might bypass problems in semantic translations of elders' knowledge. An example on resemblance level is depicted in Figure 1.

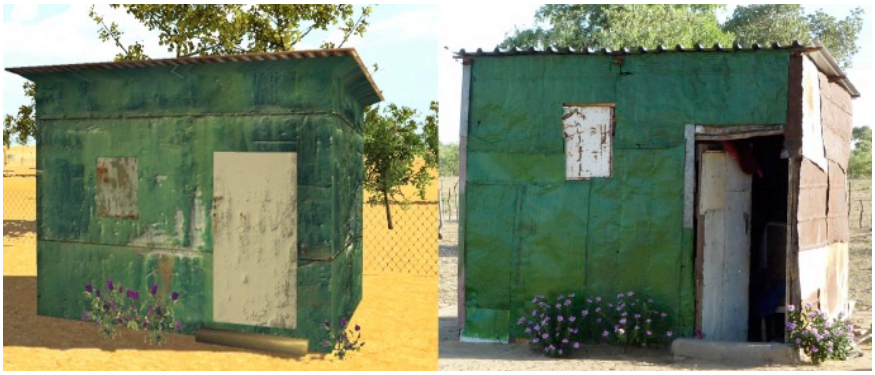

Figure 1: The house on the left is a 3D recreation of the right

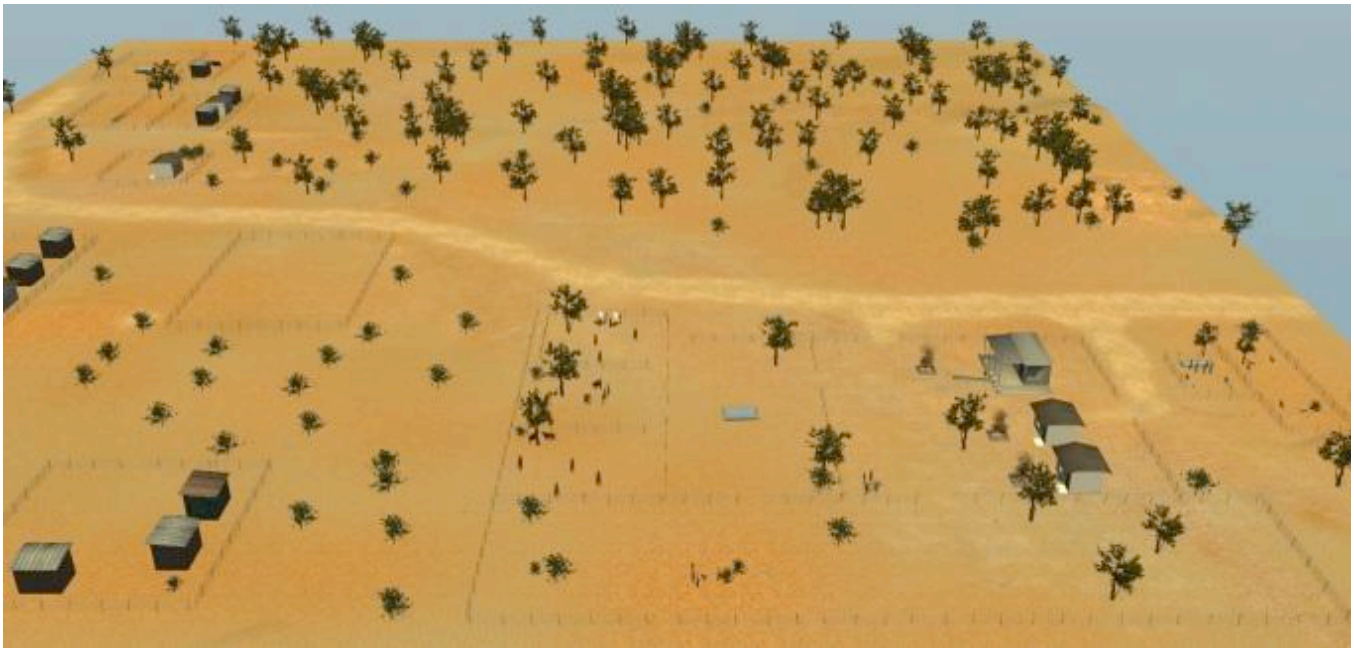

Figure 2: The prototype of the village, including all the 3D objects constructed from references.

For instance our assumption is that the houses in every homestead must have a decent graphical quality and resemblance like colors, shape, details like flowers in front, in order to be perceived by the community as the actual house they know. As developers we try to be aware of our own preconceptions, hence we wish to keep the virtual abstractions as low as possible. For instance, we assume that too low-detailed 3D models will be difficult to perceive as we intend.

The actual creation of the prototype was conducted locally in Namibia in collaboration with a researcher from the village and reference images depicting specific landmarks and homesteads [14]. The village consisted mostly of vegetation and occasionally man-made objects. Therefore, we found it important to model man-made artifacts like the water pump, since the whole community goes there to collect water and hence this place is being well-known to everybody in the community. The objects considered important at this stage of the prototype were houses, homesteads including kraals (Afrikaans: enclosure for livestock), animals, water pumps with solar cells etc. All these major 3D reference assets were modeled in Cinema4D and subsequently imported into the 3D game engine Unity 3.0 and placed according to Google Maps satellite pictures and from specifications provided by the local Herero researcher. It would be trivial to implement a wider range of artifacts and models, but at this stage of the development, we are focused on not being colored by our own ideas before sharing the layout with the community. The final result of the village and the placing of the 3D objects are depicted in Figure 2.

Beyond graphical models of the village, the prototype provides different cultural scenarios in 3D, which the elders in the community deem to be important to share with younger Hereros. These scenarios are used as event triggers, which lead to a video of a narration that explains the scenario's story and usage. The video is activated by a mouse click from the user. The corresponding video is played on a 2D plane hovering above the scenario making it possible to watch the 3D models along with seeing and listening to the recorded material. Each video incorporated into the prototype is a narration by an elder from the community; in a final solution the system should hold a larger corpus of community created and narrated video material tied to various scenarios in the system. In total, 5 different scenarios where selected, covering subjects within herb knowledge to husbandries, which are all linked to the Herero culture. In order to create attention to every scenario and to stay within the Herero culture of knowledge sharing in groups we introduced a generic character, which had the purpose to create an understandable semantic for the community. In the Herero culture it is not a tradition to have interactions with only 2 participants as knowledge is only transferred, when a larger group of the community is gathered. Each scenario was therefore surrounded by 4 – 5 characters, playing animations like pointing gestures to indicate a story is being told. Figure 3 depicts one of these scenarios including a video plane, where village elders are recorded while branding cattle.

Users navigate around the village to the different scenarios by using drag-able mouse interaction that controls the camera as a lifted first person point of view. The camera has a tilted angle to provide users with a better view of social context without losing first person point of view. The possibility to explore the virtual space by navigating was chosen because studies have shown that rural indigenous peoples can have difficulties understanding the concept of maps [11]. Research [6] indicate that the indigenous group relate to the world and objects from an intrinsic rather than an extrinsic point-of-view. The reason for compromising between using a first person point-of-view and a top-down point-of-view is to give the users of the system a better overview of the scenarios and virtual model. The focal point of the prototype is the understanding of the visualization and contextualized scenarios, not the point-of-view –but in later prototypes it will be a highly relevant parameter to investigate.

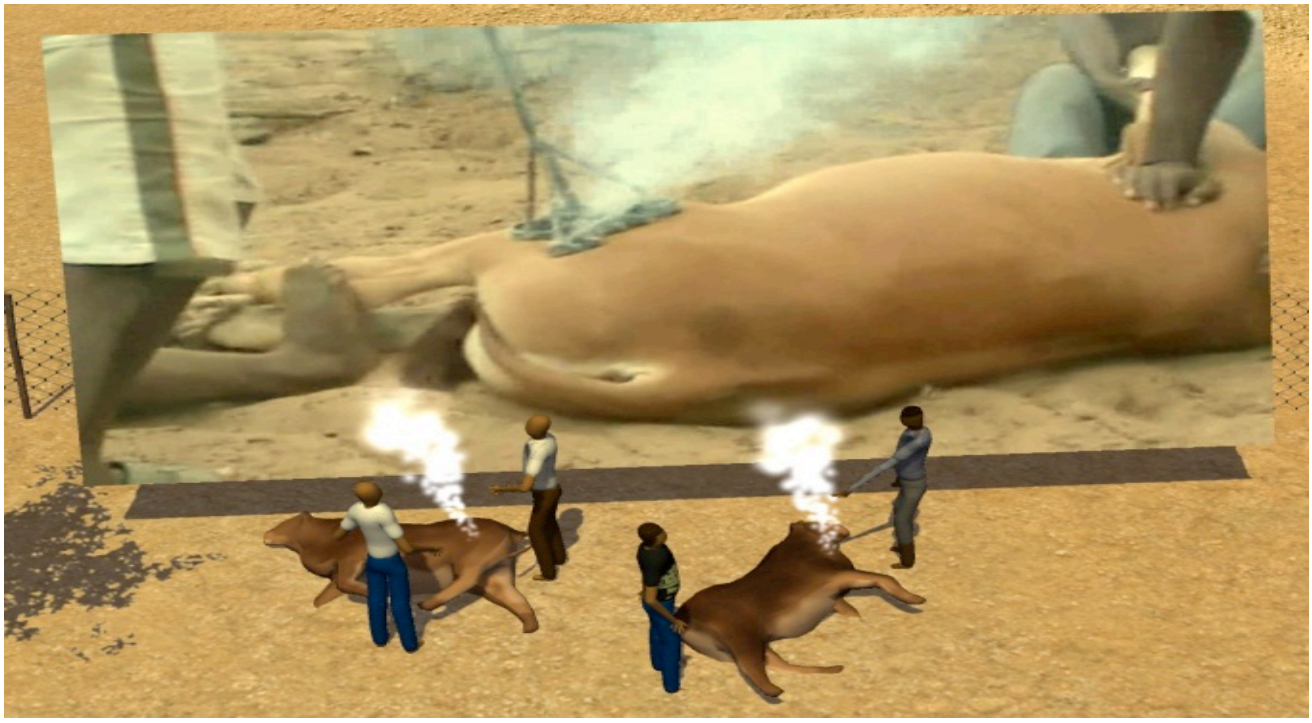

Figure 3: The cow branding scenario

4. TEST SETUP

Being a first approach in bridging the digital gap between the rural community and the unfamiliar 3D prototype, it is indispensable to gain insights into how the system is perceived and interpreted prior to continuing the development. As described in the section explaining the prototype, we are interested in discussing the system with the community, investigate if they perceive their own village and graphical objects through this foreign medium. For future development, it is important to investigate if the community understands the narrative event triggers visualized as people gathered around the scenarios and how they reflect on being presented with video material of pre-recorded situated knowledge of the village elders/themselves. We decided early on to part the community in two, where testing children would give us pointers on how they reflect on the future use of this system and if they understand the core concept of having a free roaming world to explore and learn from. The other group is the village elders, who all share an active role in their community as farmers. We need to gain their trust for any hope of continuing the research, but they also have a crucial role. They are the knowledge bearers, who decide, record and contain the chunks of knowledge, which the children need to acquire, if they at some point want to live in the village after schooling, hence making the children's learning process a 'push' approach. As stated in the chapter on Rapid Rural Appraisal [15]:"*The necessary involvement and participation of farmers (and rural people in general), since the very research process, perceives research as a mutual learning process, including also the research component in the formulation and monitoring of development projects*". Their input on our system is important for the system design, but it can hopefully deliver clues on how the elders could assume an active role in the knowledge transfer design. As Westerners we often use questionnaires to understand and measure user interaction, but as described in [15] results from African rural user questionnaires can prove invalid due to high listener satisfaction. We therefore base our test setup on the evaluation discussion described in [5], and make our test setup community centered. In [5], the authors successfully used workshops with rural people to reflect the community in the test methodology and state that cultural validity leads to community acceptance and usage. To gain trust, we believe it is crucial to base the test session on Otjiherero, which makes our active role quite small. This requires the need to brief our local interview facilitator according to our goals for the test, but indeed also to rely on his intuition for cultural understanding and discipline in leading the discussion onward. With this procedure we fear bias on the process itself, but with poor local language skills in English, the fear of misinterpreting is a great deal larger. The interviewer structures the discussion around the following questions:

1. Can the people relate their own context/village to the visualized version we present them with?
2. Can they understand the scenarios and interpret the semantics we set for them? E.g. a cow is being milked with men gathering around it.
3. Do they understand the virtual characters as event triggers? Does it make sense for them?
4. Do they have any specific ideas or reflections to add to the development?

The test team consisted of the authors, who developed the prototype and knew about the future goals of the project. The discussion around the prototype and presentation was facilitated by a local researcher, who is a native speaker of Otjiherero and who possess a deep understanding in conducting semi-structured interviews with rural communities. Another local researcher, also speaking fluent Otjiherero, joined the team to help with video recording the sessions. He had a supplementary role in helping interpret the dialogue for the research team while the interviewer was busy interacting with the community. This helped the team members without knowledge of Otjherero to understand key points and assisted if problems or the need for clarifications occurred. We believe that transferring the complete control to the

local interviewer could slant the objectivity of the test, hence making it hard to inspect the results and interpret the video. For translation from Otjiherero to English, and insight in analyzing reactions, which we do not perceive during the session, the sessions with the children and elders was documented by one statically positioned video camera facing the test group, and one where the recorder could move freely around.

5. TEST RESULTS

The session was conducted in a period of 2 days in the eastern part of Namibia in a small village with approximately 20 homesteads counting around 7 persons in each. The people living there are members of the Herero tribe, which counts app. 240.000 individuals living in Botswana, Angola and the majority in Namibia. After introducing ourselves to the community, we asked the children in the city to partake in our first system test. It was possible to find 7 younger people from age 10-18, who were back from the capitol Windhoek for Christmas holidays. Subsequently 8 rural residents including 2 village elders agreed to participate in the second walkthrough. The village has neither electrical power nor cellphone reception, which meant that our prototype program on the laptop was supplied from a car battery. The recorded videos were first translated by the interviewer, and subsequently an external translator transcribed the sessions for ensuring optimal documentation material. The two following sections cover key points from the two test groups' first encounter with a 3D representation of their village.

5.1 System Walkthrough with the Children

The children, although being in a good mood, placed themselves reluctantly a bit far from the laptop, which made it hard to see our program due to the sunlight. We opted for moving inside a house, but the locals said that people never sit inside and talk. The children moved closer after a smaller negotiation and there were no issues in perceiving the visualization. We asked the children, if they knew how to use a computer, some replied that they have never used one, and some said they have only been using computers in schools in Windhoek (Figure 4 depicts the youths positioned around the prototype.).

Figure 4: Village children are presented with the system.

The children were asked if they knew what to do if a goat or cow is sick. They said: "We never heard a story for that." The interviewer asked:" The elderly people are now left with this knowledge, so if the elderly die, what happens with this knowledge? Children:" It will die with them as well." The children were explained the concept of the system, and after being slightly passive they loosened up. They were asked to tell what they saw, and the children replied:" People! Fire! Houses and trees!" This means that our visualization was connected to their mental images of the various objects. Previous studies have shown [11] that people from the rural community are not able to read maps, but the children were able to perceive and link the objects by using a tilted camera perspective. The test took place outside one of the newer village houses, and suddenly some of the children recognized the same house in our 3D model. "This is here. It is this house." They said this after they recognized it from the sides of the house and the fires in front of it. A discussion arose amongst the children after panning over a scenario on slaughtering a goat. "It's a goat. It's a sheep." The children suddenly came to agreement, and said that sheep do not have small tails. This is by our opinion an indicator on the importance of visual quality and the fact that they were inspecting more detailed than we have foreseen. When panning over the cattle branding scenario, the children immediately saw branding irons, smoke and cattle. They saw the video recorded by one of the elders on branding cattle, and the interviewer asked if it was a story. The children said that the cattle were in the kraal. They said that one man was pointing, which they linked with telling a story. During the test only a couple of the younger boys tried interacting with the system. We have no doubt in, that they will be able to interact with the prototype, but the focus of the test was to investigate if the children understood the 3D model and the basics on how to use it. It was difficult to motivate the children in sharing their thoughts during this session, but with a small amount of explanations and concept sharing we believe that they would understand the goal of the system in more detail. The entire session lasted for 27 minutes.

5.2 System Walkthrough with the Elders

The elders (Figure 5), who are digitally illiterate, quickly spotted the resemblance with the digital model and where the test was situated and started discussing how accurate the model was. With the aid of the reference images we only modeled one block of concrete next to a fire located in front of a house. The fact that there were two blocks of concrete frustrated the elders a bit, and they were unsure of their own accurateness. They also had difficulties linking the de facto trees with placement of the virtual trees. This indicates that they not only understand the objects they see, but indeed also the importance of placement. When discussing the scenario near the cattle in the kraal, the elders told us that planted trees do not grow inside the kraal, an older man added: "It's not a planted tree, it's a wild tree (Otjindanda), just look the way it grows!" During the development we did not understand the importance of making the trees naturally looking; the trees were merely assumptions from reference images. The elders understood the scenario concerning the milking of the cow, but they added that it looked more like the person was tying the cow.

The scenario visualizing the slaughter of the goat was easily understood, and the interviewer asked them who was telling the story? They said that it was the one in the middle because he was pointing and showing the goat to us. They said:" He is pointing and showing what to be done." These facts imply that the elders are reasoning heavily from the objects they see, which is positive for developing a system like the one proposed, but it also indicates that a large effort in the actual design and modeling of fauna and objects must be made. The interviewer asked the elders: "Which way do you think is the best, when you look at it?" "They are good in their look (translator: the quality) and in the sense that they will be kept there forever and they will never be forgotten." In the last part of the session one of the villagers replied to the interviewer asking if it was good to teach children: "Very much!

Especially those township children, they don't know village stuff, they will learn from that." The elders did not try to interact, and we believe that the reluctance for trying is strongly linked with them sitting in a group, where none were forced to be active. The session lasted 23 minutes.

Figure 5: Village elders are presented with the system

6. DISCUSSION

What was apparent from the observations was the importance of similarity with reality. So far it remains largely unclear, what aspects are relevant, e.g. what makes a hut or a tree recognizable. The observations of the two groups gave us some hints on this like the difference between wild and planted trees along with their placement, but a more thorough and systematic investigation is necessary to capture the relevant parameters. The characters, which were included to make the scenarios more lively and believable, triggered comments that are related to this issue of degrees of similarity. The character exhibiting the pointing gesture was consistently interpreted as the narrator, as he was showing something to the other characters and the users. This was unintentional as the characters in the current iteration just pose random gestures. But it signifies that the characters can play an important part in the scenario and possibly in narratives driven by virtual storytellers.

This is in line with the general idea is of re-contextualizing the abstract knowledge facets by using 3D visualizations [17]. The characters would in this case be used to trigger interest in the available narrations (videos). Thus, they would act as autonomous characters re-creating part of the scenario. The idea of virtual characters as autonomous interaction partners has matured over the last years with research focusing on the conversational abilities (both verbal and non-verbal, see also Figure 6) and the synchronization in multi-party interactions (e.g. [18], [19]). In our context, agents would be assigned different roles like narrator, listener, observer, etc. By their interactions in the scenarios complex behaviors would emerge that mirror the original settings.

This can be of interest in two different ways. (i) As mentioned before, to trigger interest in the available narratives, which present in-depth information through video recordings. (ii) From the observation protocols it became clear that some information is missing from the (2D) recordings, e.g. from which side to milk the cow. This information could easily be visualized in the 3D environment by the characters performing and thus showcasing the actual action. Thus, adding agents to the scenario could not only serve as additional "eye-candy", but take a crucial part in the information distribution process itself. Even though the findings for a shared visual design space are encouraging, and from a designer's point of view highly interesting in sense of further and more detailed development, there are a couple of concerns, which will color the next phases of the development. Firstly, it is from this tentative experiment unclear how the individual perception of 3D graphics differs between designer and user. To ensure a solid foundation for investigating the potential of 3D game mechanics, visualizations and virtual worlds, and to open up a shared design space, we must define the building blocks we wish to build it upon. E.g. the experiment gave pointers towards the detail of the fidelity on the size of goat tails, but is this important for all objects? The realism of the graphics is depending on computational power, so where is it possible to reduce polygons to allow more content? Secondly, we focused heavily on the man-made objects, which did not play any role for the two groups during the discussions. This indicates that we as Westerners focus more on materialistic objects, where the villagers' focus is on the ecology. This is an unsupported claim, but it could be an interesting facet to investigate, hence it also could impact our perception and re-creation of virtual objects. Thirdly, from an HCI and cultural perspective, we must consider our final product's place and form in the context it will be designed for. The author describes in [20], that designers must carefully evaluate the actual appropriateness of a technological solution, thus it can prove to be harmful on unforeseen parameters. We must make sure that the side-effects of situating and sharing technological solutions with indigenous groups do not collide with their modus operandi -as designers we have an obligation to thread carefully while we seek the optimal design and implementation.

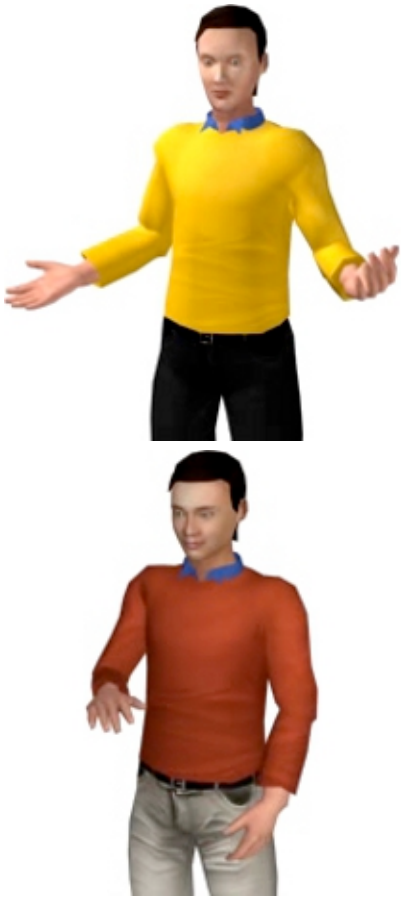

Figure 6: Virtual agents exemplifying the use of communicative gestures

7. CONCLUSION

For allowing African youth from rural villages in Namibia to learn from their ancestral and cultural heritage we have developed a prototype for knowledge transfer. The elders in the community record videos of important cultural meaning, which is made available through a 3D visualization of the village, from which the knowledge originates. The 3D model is a tool for leaping over the literacy and digitally illiterate gap between young people studying in large cities and elders in rural areas. With the use of context relevant scenarios the users can obtain crucial information from the prototype and obtain knowledge they previously received through interaction in the local community. The prototype was tested in a local village in Namibia, where results indicate that both elders and the younger people understand the 3D visualization, and they also reflect it with respect to accurateness of graphical quality and placement of knowledge. Being a tentative first approach in aiding young people preserve and learn from their cultural background, there is much work to cover for ensuring a viable system, but we have strong confidence in the impact of visualization in interactive systems as a component for knowledge transfer.

8. FUTURE WORK

For developing the system further and to be able to have a layer of controlling the potentially huge amount of community collected video material, it can be hard to neglect the use of a GUI as a controlling component between the end users and the knowledge to be transferred. We have a concern in possibly obstructing the goal by implementing traditional Western designed GUI's. The authors in [16] share some interesting insights on how to develop a GUI with the use of cultural metaphors. E.g. in Sub-Saharan cultures the calabash is used for storing mostly fluids for a shorter duration and talking drums have been mediating knowledge and messages between communities for many years. Instead of placing Western icons like arrows and buttons, which the authors in [5] test to be counter-intuitive; it could be interesting to develop and investigate cultural metaphors in the Herero community. In our proposed system the calabash could be storing the community collected video material for a short amount of time until decided whether to include it in the system. The talking drums could serve the purpose of sending information on these videos to the developer team, on a larger scale transfer them to a nearby village system, which has not collected the specific knowledge yet or to specific students using the system in the capitol.

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