

An exploratory digital environment for learning about southern African pre-colonial urbanism – A usability study

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Abstract:

Studies of early urbanism have been traditionally and continually influenced by Eurocentric and colonial ideologies that used the so-called trait-list of criteria that settlements must exhibit to be considered urban. These include social stratification, large and dense populations, centralization of surplus food, monumental public architecture, literacy and the study of science, math and astronomy (LaViolette and Fleisher, 2005). The criteria well portray Southwest Asia and Mesoamerican early cities but do not transfer to early African agglomerations. Thus, African urban origins were considered mostly a colonial phenomenon and, in any case, foreign (Connah, 2001). Africanist scholars have effectively demonstrated that African urbanism and centralisation have little in common with models applied elsewhere (Connah, 2001; Haour, 2005; Macintosh and Macintosh, 1984; Pikirayi, 2001; Sinclair, 2013). Unlike on other continents, prehistoric African towns are characterised by the lack of permanence and by high mobility; no single path or clear link between the development of central places and dependence on or control over the farming hinterland can be traced; power is focused on resources and people, with continuity provided by authority rather than by location in the landscape (Leyser et al., 2018). Pre-colonial centralisation and urbanisation in Africa, are important themes for research on and learning of the African past, and for transforming the way that people have traditionally perceived the African landscape. For example, most students (in Africa and globally) at higher education levels are not aware of any forms of pre-colonial urbanism on the continent.

One approach for raising awareness of pre-colonial urban settlements on the African continent is to make information available and provide learning opportunities. Online environments and the incorporation of visualizations are ideal for this, especially in instances where the site of study is inaccessible. Online visualizations of geospatial information have been utilised in many other parts of the world in cases where archaeological sites are inaccessible, either physically, conceptually or to the public. Geospatially referenced archaeological data can be used to make maps, 3D models, virtual reality or digitised drawings, used for disseminating information about a site to an audience. One such method is story mapping. Story mapping involves a geospatial data-driven form of storytelling. Maps, photos, videos and other related analytical visualizations accompanied by explanatory text are used as a tool to effectively communicate geospatial information to an audience. Story mapping attaches characters and plots to data in a way that is engaging to a reader and makes the assimilation of information more natural, making it an ideal educational tool (Berendsen et al., 2018). There have been several projects in the past that utilised archaeological geospatial data in an educational digital platform, however, examples of similar projects for southern African archaeological sites are limited (Scianna and Villa, 2011).

Such educational digital environments and visualizations must be carefully designed to support the learning process. Especially for non-experts, it is essential that available working memory capacity is not overloaded, which occurs when learners are confronted with instructional material that is laid out ineffectively. Through eye-tracking, the visual search can be mapped as a learner looks for relevant information amongst different sources (Jardodzka et al., 2017). Traditional usability testing techniques such as the System Usability Scale (SUS) can be used to identify user satisfaction and interface effectiveness and efficiency. Traditional techniques and eye-tracking can be used in tandem as complements to each other, providing more in-depth insight into the results of a usability assessment (Wang et al., 2019).

For this study, an online digital exploratory environment was developed that presents archival and geospatial information related to early Tswana urbanism using a variety of media. Seoke, a site characterised by extensive stone-

walling, located in present-day Botswana, was identified as a case study site. Seoke was the capital of the Bangwaketse, a Setswana speaking people, in the late 18th century. Stonewalling was an expression of identity and power for the Bangwaketse (Morton, 2018) and the stone wall structures, which are still present today, are the most visually apparent remains of the settlement. For various reasons, this cultural heritage site is currently inaccessible to the public. The drive behind the development of the exploratory environment was in response to the educational potential of Seoke, considering its physical inaccessibility.

The exploratory environment was presented as a story map that integrated various images, 2D maps, 3D visualizations, videos and archival links. Two usability assessments were conducted with the story map as the stimulus—first, a usability questionnaire and second, an eye-tracking study. Participants were non-expert students and were recruited through email from three universities – two in South Africa and one in Botswana. The usability questionnaire received 111 responses and was conducted online. Participants were asked to explore the story map freely and then to answer a questionnaire about its usability and their experiences. The questionnaire included standard SUS questions in addition to questions pertaining to information recall, perception and the value of the story map. The eye tracking study had 16 participants and was conducted at the eye tracking lab in the Department of Informatics at the University of Pretoria. The eye movements of participants were tracked as they explored the story map freely and performed tasks when prompted. Participants in the eye tracking study were also asked to complete a post-study questionnaire. The online usability questionnaire and the eye tracking post-study questionnaire were similar, however, the usability questionnaire had additional questions that pertained more specifically to the usability of the story map. Participants were not allowed to participate in both assessments.

Overall, the exploratory environment was effective in accomplishing the aim of the study, which was to create an environment for learning. Participants were able to learn while using the exploratory environment and performed very well when recalling information and applying information learned, with a 73% average answer accuracy. The exploratory environment received an overall SUS score of 65. At the item level, the SUS questions revealed that users found the various components of the exploratory environment to be well integrated and reported that they would like to use it again. However, participants felt that technical support and prior knowledge were needed to use and navigate the story map, which influenced its usability. The eye tracking study revealed that participants found navigating the archive, in particular, to be quite difficult. Regarding the 3D visualizations, Esri's CityEngine was used to model scenes with functional realism (Ferwerda, 2003). However, as the software is designed for modelling modern cityscapes, the 3D models were unable to capture the organic visual attributes of the site with true realism and appeared too 'clean' and geometric. As the 3D models were crucial in the conceptualization of the site in light of its inaccessibility, this was a concern. Nevertheless, this did not affect the participants' perceptions of the 3D scenes appearing organic and participants were enthusiastic and reacted positively to the models. About 86% of participants perceived the realism of the models as moderate or better and 72% of participants felt that the graphics and realism were attractive attributes of the models. Furthermore, participants relied on the 3D models for understanding and the physical conceptualization of the site and reported that the 3D models made learning about Seoke more engaging.

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