CS/IT Honours
Final Paper 2021

Title: MASH: A Concept Map Creation Tool for Mapping Cultural Heritage

Author: Yashkir Ramsamy

Project Abbreviation: MASH

Supervisor(s): Hussein Suleman

Category	*Min*	*Max*	Chosen
Requirement Analysis and Design	*0*	*20*	
Theoretical Analysis	*0*	*25*	
Experiment Design and Execution	*0*	*20*	15
System Development and Implementation	*0*	*20*	15
Results, Findings and Conclusions	*10*	*20*	20
Aim Formulation and Background Work	*10*	*15*	10
Quality of Paper Writing and Presentation	*10*		10
Quality of Deliverables	*10*		10
Overall General Project Evaluation (*this section allowed only with motivation letter from supervisor*)	*0*	*10*	
Total marks		**80**	

MASH: A Concept Map Creation Tool for Mapping Cultural Heritage

Yashkir Ramsamy
RMSYAS003
University of Cape Town
RMSYAS003@myuct.ac.za

ABSTRACT

Digital Archives are digitized collections of historical data, made up of various topics, events or people. Prior to digitization, archived material were stored physically and were only available for in-person viewing. Digital archives are an approach to making this historical information publicly and widely available through the internet. Generally, the content stored in these archives are simple in nature, yet their contexts and relationships are not clearly defined among them. This paper presents a tool that allows users of digital archives, amongst others, to better define these relationships and contexts through concept mapping. We conducted a feasibility investigation to assess the user experience and seek feedback on its design from the evaluation's participants. Based on the results of the investigation, it was noted that the tool worked, was comprehensible and usable, but lacked aesthetic features or additional interactive points. In conclusion, we demonstrated that a tool for viewing interactive concept maps is feasible to implement, comprehensible, and useful. With minor tweaks, it can be embedded into a practical setting.

KEYWORDS

digital humanities, digital libraries, digital archives, digital objects, concept maps, cultural heritage preservation

1 INTRODUCTION

Collections of recorded information about a subject matter(s), event(s), or person(s) are referred to as archives. Usually, these archives are stored in museums or institutions around the world, making it possible to only view its records in person. With the progressive development in technology and the internet, the maintainers of these archives have the ability to now store or duplicate them digitally and make them available for viewing by anyone over the internet. These are referred to as Digital Archives (DAs). DAs store recorded information as digital objects that can be partly or wholly made up of text, images, videos, files etc. The intention of DAs are to provide long-term access to these digital objects through digital preservation. Local examples of these DAs are the Five Hundred Year Archive [1] and the Digital Bleek and Lloyd Collection [2], where both of these contain archived cultural heritage material pertaining to South Africa.

Although simple digital objects exist within these DAs, it is often the case that their contexts and relationships are not clearly defined or understood. Researchers attempt to better define this by producing research monographs that can include timelines, diagrams, concept maps or other representations of knowledge. This, combined with the content of the simple digital object from an archive, introduces more layers of information for a particular archived record that can better define its context and relationships among other objects in the archive. Software tools for the specific creation, organization and administration of monographs exist. However, existing software tools made for other purposes, such as slideshow presentation tools, simple diagramming tools, calendars etc., are repurposed, by using atypical practical applications of a tool, to meet the needs of a researcher. A researcher may want to illustrate a timeline of events in the past and does so by creating a calendar with these events marked on each month in a given period and saves his creation with a screen capturing tool; as an example. This is not what a calendar is typically used for and demonstrates why the researcher needed a separate tool to save and share his creation. This can sometimes be a cumbersome process.

1.1 Project Context

Since the relationships and contexts are usually ill-defined, a good technique to use to illustrate relationships among the digital objects is to make use of concept maps as they are good at defining relationships and providing a clearer context into an object's environment [24]. Hence, diagramming tools like LucidChart[3] and Diagrams.net[4] are useful tools for illustrating the relationships among digital objects only, in a static fashion. However, a short-fall of these tools is that they do not offer interactivity or link objects to supplementary resources, like web-pages; it requires a level of technical knowledge. Nor do they allow a facility to create the supplementary resources for the digital objects. Omeka[5], a tool for exhibiting content, has the facility to display the static content of digital objects but lacks in displaying the relationships and an ability to offer interactivity.

Therefore, this project investigates a tool where one can create and/or save concept maps (CMs) that represent the relationships among these digital objects and offer interactivity defined by the abilities to, create and display supplementary information for the corresponding object, traverse the CMs, search the objects within the CMs. This paper, in particular, will describe the final interactive output of the created CMs and supplementary content; this feature is referred to as the Complex Object Mappings Renderer (COMR). It

[1] Five Hundred Year Archive: https://fhya.org/
[2] The Digital Bleek and Lloyd: https://lloydbleekcollection.cs.uct.ac.za/
[3] Lucidchart: https://ludic.app/
[4] Diagrams.net: http://diagrams.net
[5] Omeka: https://omeka.org

will also provide an analysis of the usability of COMR to determine whether its use is a feasible method for visualizing cultural heritage material and exchanging knowledge between creators and readers of the maps. Thus, our research question is to determine the answer to what the user's experience will be when using a tool to model and view relationships among digital objects and its supplementary information in a concept map format.

1.2 Paper Structure

This paper is comprised of 5 sections. Section 2 describes any related work and literature that may be relevant to this project. Section 3 describes the problem that this paper addresses, the tools and COMR's design and implementation, and the experiment design. Section 4 describes the results and the findings from the study described in section 3. Section 5 concludes the paper by providing conclusions based on the outcomes of the study conducted in section 4, as well as the limitations of the study and tool's implementation, and any relevant items left for future work.

2 BACKGROUND AND RELATED WORK

The project began by researching the concepts related to digital archives, as well as the existing tools for digital object visualization/exhibitions and diagramming systems and techniques that are not domain bound used for mapping content.

2.1 Existing Tools for Digital Object Visualization

2.1.1 Omeka. Omeka is an open-source content management system (CMS) for use by digital libraries. It offers exhibition creation, content organization and display. Its open-source nature has facilitated the creation of plugins for its plugin architecture. Omeka is a web-based solution and requires a web server and is often compared to WordPress [27]. WordPress is a free and open-source CMS used for building and managing content-orientated websites, with community made plugins that extend WordPress' functionality further[29]. Omeka comes with a robust exhibit creation tool, which allows users to create exhibits with web pages that are composed of digital objects from the repository stored with the Omeka instance [1].

2.1.2 Collective Access. Collective Access is an open-source digital library management tool and digital exhibition creation software [4]. Collective Access is built on a framework that manages data modelling, contains a media framework that can manipulate and convert images, videos, audio, text and documents, and an interface for cataloguing and traversing collections [4].

2.1.3 Islandora. Islandora is a solution that uses a Fedora Commons backend, which is a software architecture used in building digital archives, with Drupal6 as the front-end solution [17]. Drupal, much like WordPress, is a free and open-source CMS used for building and managing content-orientated websites[9]. Islandora extends the Fedora Commons file and metadata ingestion methods, meaning that Islandora accepts the same files as Fedora Commons [27]. Islandora offers Solution Packs, which are custom Drupal modules tailored to Islandora's functions for digital object management and display but none of the provided solution packs offers any additional diagrammatic ability to visualize digital objects [3].

2.2 Mapping Techniques

2.2.1 Concept Maps. Diagrams that organize information in enclosed shapes with visually represented relationships are known as concept maps [25]. The use of tools that generate interlinking information in an organized manner is referred to as concept mapping [25].

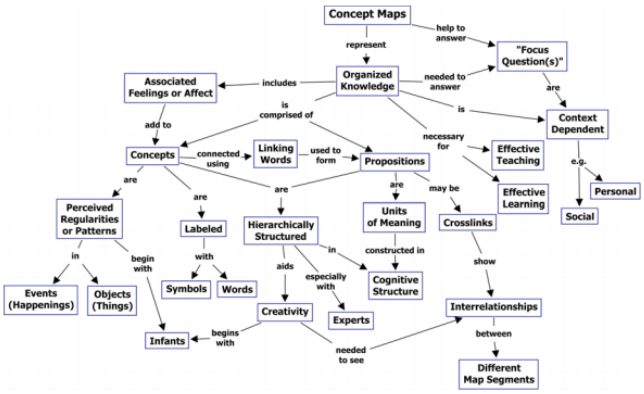

Figure 1: A Concept Map [25]

Figure 1 displays an example of such a concept map. Concept maps allow their viewers to understand relationships between objects in a concise, reduced fashion [5]. Despite this, an increasing amount of information on a concept map is inversely proportional to its utility, attributable to the high number of related links between objects [28]. In an instance where a researcher requires the input of more information or a change of relational links, it may prove to be difficult [28]

2.2.2 Topic Maps. Topic maps are like concept maps in that they also visually represent relationships between informational objects. The difference between concept maps and topic maps is that topic maps represent this information with formally defined and structured graphs [16]. Topic maps are constructed with a specialized version of eXtensible Markup Language (XML) - XML Topic Maps (XTM) [13]. Topic maps are defined in an ISO standard, ISO/IEC 13250 [16, 22]. This means that Topic Maps are an industry standard and are machine-readable maps. This is also implied by its use of XML, which is designed to be machine-readable [16]. Topic maps are not restricted to a domain, or the types of data that it can model [22].

2.3 Diagramming Systems

In terms of how they show digital content, CMSs are simple. Digital objects are not represented through visual relationships within these tools. Diagramming platforms allow for the creation of concept maps and the depiction of relationships between items or

objects. Many of them are web-based programs. To create concept maps and other diagram types, tools like Lucidchart[6] and Diagrams.net[7] provide easy-to-use user interfaces for this purpose. There are standard shape libraries for nodes in both tools, as well as a user-supplied custom shape library for nodes imported by the user. In order to create custom shapes, one can use either XML documents or images[8, 18]. LucidChart, however, and many other similar tools, do not create interactive diagrams and instead produce static outputs in PDF or other image formats. One can incorporate a custom link into a shape in a Diagrams.net interactive diagram[7]. For a non-programmer, this will introduce a new and challenging learning curve as it is implemented in JSON [6].

3 METHODS

The project attempts to determine if the resulting feature (COMR) can produce understandable and useful interactive diagrams for its viewers. This section describes the research question posed, the proposed feature's design, and the evaluation method for the feature.

3.1 Feasibility Investigation

For COMR, the research question is:

What is the user's experience when using a tool to model and view relationships among digital objects and its supplementary information in a concept map format?

Therefore the specific objectives of this project are:

(1) To assess the feasibility of the design and implementation of this tool.

(2) To assess the end users' understanding of created outputs.

(3) To assess the comprehensibility and usefulness of the interactive points within created outputs.

The following subsections will discuss the design of COMR, in conjunction with the evaluation used to address the above research question and objectives.

3.2 System Design and Implementation

3.2.1 Architecture. The tool, referred to as MASH in its entirety, is a web-based application designed for use on desktop/non-mobile devices. MASH is made up of two major features; the Complex Object Creator and Editor (COCE) and the COMR. COMR depends on COCE's outputs to render concept maps and supplementary information. COCE is used to create maps and the supplementary information for each object on the map. COCE then converts this into a serializable format that COMR is able to process and display as an interactive concept map.

MASH is served using the Web Server Gateway Interface [12] convention through the Flask microframework [26]. Data persistence is served through MongoDB Atlas, a cloud database-as-a-service platform [20]. This houses the serialized concept map data created by users on COCE.

[6]LucidChart: https://lucid.app/
[7]Diagrams.net: https://diagrams.net/

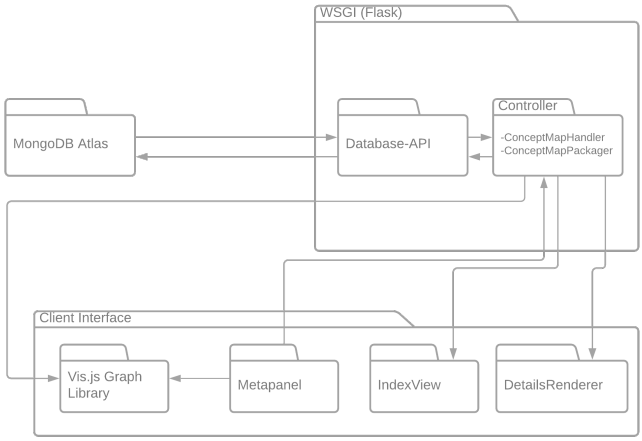

Figure 2: High-level view of COMR Architecture

Figure 2 illustrates this abstraction of COMR's architecture on MASH. It follows an architectural pattern similar to the Model-View-Controller (MVC) pattern where the implementation of the Model is a simple database API layer as data does not need to be edited but only read from the Database. The below are descriptions of each package (and feature, if appropriate) illustrated in Figure 2.

MongoDB Atlas. This is NoSQL Database [21] based on MongoDB [20]. Data is stored as documents, where the format of these documents are JSON objects. COCE exports created maps and supplementary object information as compact JSON objects through the Database-API to MongoDB Atlas for permanent storage.

WSGI. This is a Flask-based [26] web-server installed on Heroku, a platform-as-a-service based on Amazon's AWS [14]. Heroku supports various languages, including Python, which Flask is written in [14].

Database-API. The Database-API serves as the Model component. It contains the logic for accessing, reading, updating and deleting items in the MongoDB Atlas database. It is written in Python. COMR uses this to retrieve concept map data for displaying via its Controller.

Controller. The controller is a high-level abstraction of the various functions that make up the server-side processing for retrieving and sending concept map data to the client. The controller is comprised of the ConceptMapHandler and ConceptMapPackager.
The ConceptMapHandler uses the Database-API class to get JSON formatted objects from the Database. This is activated once a User requests to view a map. The ConceptMapHandler will receive the request from the ClientInterface, retrieve the requested map from the database and return the JSON map object to the client. Maps are rendered on the client-side and not server-side. When a user selects an object to explore on the concept map view in COMR, a request is passed to the ConceptMapHandler that then in turn serves the page for which the extended details of that object can be shown; this will be described in the DetailsRenderer section.

The ConceptMapPackager is activated once a user requests to view a map offline. It clones the view the ConceptMapHandler will generate and compresses the resulting outputs into a .Zip file, which is then sent to the user as a downloadable file. Both viewing options are accessible from within COCE's dashboard, where a user requests to view a project. The ConceptMapPackager's trigger is activated by navigating to a path on the domain where MASH is located and entering a query string that contains the ID of a concept map to trigger a downloadable file. The structure of URL is as follows:

```
http://<domain>/export/<mapID>
```

Where:

(1) <domain> : represents the domain of MASH.

(2) /export/ : is path to indicate a downloading action should occur

(3) <mapID> : represents a concept map ID. This information must have been gathered before the URL is built.

ClientInterface. This is the "front-end" of COMR. When a user requests to view a map, this page is rendered. It uses embedded data provided by the ConceptMapHandler. It is written in React, a Javascript Front-end library [15]. It is comprised of the Vis.js Graph Library, the Metapanel and the IndexView. Figure 3 shows COMR's interface. The main map title and project description appears at the top of the screen with the visualized JSON object appearing in the center; this is rendered by the Vis.js Graph library. Figure 4 shows the Vis.js rendered concept map displayed in Figure 3.

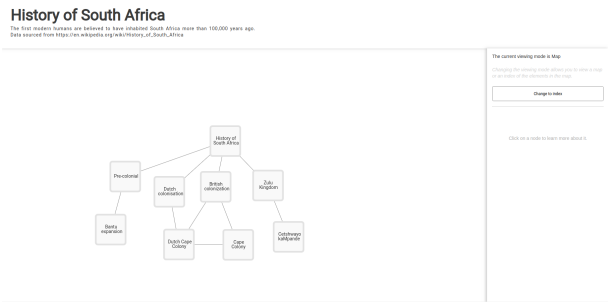

Figure 3: COMR Interface

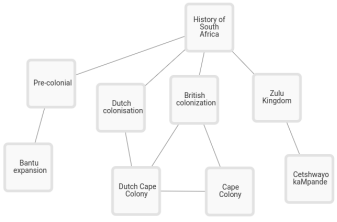

Figure 4: A generated concept map

Vis.js Graph Library. This feature renders the JSON object received from the ConceptMapHandler. The JSON object is stored locally, and the map is generated locally as well. It is done so through Vis.js, a Javascript library used for diagramatic visualizations [2]. Each object in the map is referred to as a node, and is hoverable and clickable. On a node hover, a node will change colour to bring it into focus to the user. When a node is clicked, it highlights all the edges which the node is connected to and activates the Metapanel, which will be discussed in the following section. Each node carries its own data pertaining to its name, title, brief description and full description, referred to as "details".

Metapanel. The Metapanel is located to the right side of the screen in figure 4. This panel contains a control for changing between the Map and the IndexView, which will be discussed in the following section. On a node click, the Metapanel displays the clicked node's title and brief description, with a button to allow the user to continue to view the details if desired. Figure 5 shows an example of an activated Metapanel displaying a node's title and brief description.

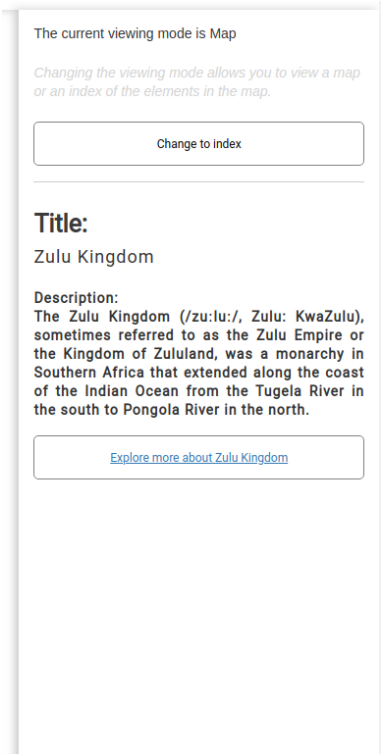

Figure 5: An activated Metapanel

IndexView. The index view is a textual list representation of the concept map. It uses the embedded data stored in the browser to create the list. The list allows for nodes to be searched through its titles and its brief descriptions. The search feature allows 3 ways of searching:

(1) "contains" search: which will check if the node's description or title contains the phrase.

(2) "equals" search: which will check if the node title or description exactly matches the phrase.

(3) "startsWith" search: which will check if the node's title or description starts with the phrase.

Each list item is clickable to allow the user to travel to the details page of the node, displayed by the details renderer. This will be described in the following section. This feature is shown in Figure 6.

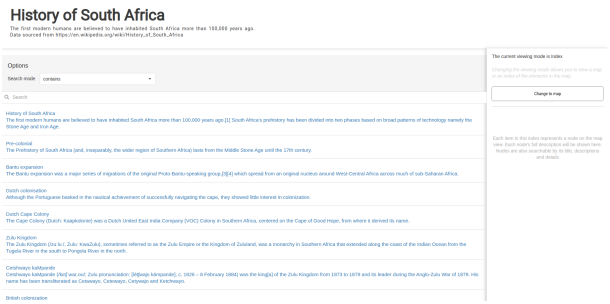

Figure 6: An Index View

DetailsRenderer. Each node carries its own details data. This details data is constructed by the user in COCE and is stored in an HTML format within the JSON object. This data is then embedded into a details page, by means of a Javascript insertion. Each node will have its own details page generated on the web-server when a user requests to view a map itself. This is done by a function call to a python script that sequentially embeds each node's details into a predefined template. These pages are stored temporarily and removed after 24 hours if it is not re-accessed on Heroku's platform within that time period, for the purpose of saving storage space.

In the offline view of the map, details are displayed inline on COMR rather than as separate pages. This is to allow for portability and less complex preservation. The difference between the offline and online view in the details renderer stemmed from an implementation decision. The offline view of the website is captured using GNU Wget [23]. A limitation of this tool is that it does not capture dynamically inserted resources, by means of Javascript and React in this case, into a web page. The links to the details page for each node is dynamically inserted into the web page, as a side effect of using React as a front-end with Flask. Therefore the decision was made to embed each node's details field into the browser and rendered inline in COMR display.

Figure 7 shows the online view version of the details renderer, whereas Figure 8 shows the offline view for a node. Figure 7 displays the page that a user will see once they click on a node, this page is opened in a new tab in the user's browser. Figure 8 displays the dialog that will appear over the concept map in the user's current tab. Both views contain the same information, but are displayed differently by these two methods.

Figure 7: Online View of the Details Renderer

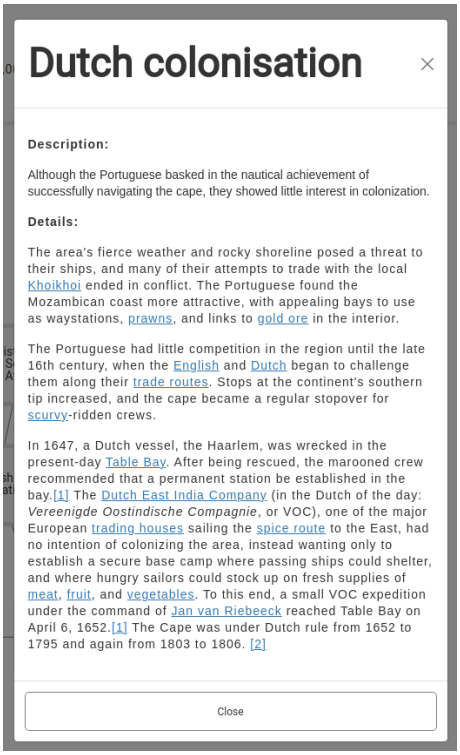

Figure 8: Inline View of the Details Renderer

3.3 Experiment Design and Execution

3.3.1 Evaluation Task. The aim of this project is to assess whether this tool is usable, understandable, and feasible to implement in a realistic setting. A questionnaire was made to meet this aim. Please see Appendix A for the full questionnaire. It is made of 3 sections:

(1) Demographic Information.

(2) COMR.

(3) General Response and Feedback.

Demographic Information. This section is composed of 2 questions in total. One pertaining to the education level of the participant and one pertaining to their specialization.

COMR. For this section, a list of 10 Tasks were formulated; these tasks covered the use and features of COMR to assess the aforementioned aim and the specific research objectives. The tasks were the following:

(1) From the dashboard, select a project and view its map.

(2) Browse the map.

(3) Zoom-in and zoom-out to view nodes.

(4) Pan around the map to view nodes.

(5) View the associated links and content of a node.

(6) Find a brief description of any of the nodes' content.

(7) From the map, learn more information about a node, beyond a brief description.

(8) Change the view from the map to a list index view, and then change it back to the list index view.

(9) Search for nodes with the list index view.

(10) Download the project.

The tasks were then followed by scaled-response questions from the Usefulness, Satisfaction, and Ease of use (USE) Questionnaire. The USE Questionnaire evaluates a user's perception of usefulness, ease of use, satisfaction, and ease of learning [11]. The scale chosen was scored from 1 to 5, with 1 representing "strongly disagree" and 5 representing "strongly agree".

General Response and Feedback. The last set of questions were general response questions that required textual feedback from the participant about their perceived positive and negative aspects of COMR, and their overall experience.

3.3.2 Process. COMR was evaluated via a LimeSurvey questionnaire, hosted on the University of Cape Town's (UCT) Computer Science servers. To participate, an individual needed to have a stable Internet connection and a desktop computer. Specializations in Historical Studies or similar were preferred but not a criterion. Participants were recruited directly through the FHYA team, through social media, and direct emails to staff departments within the Humanities faculty. To encourage participation, participants were compensated R55 for their time spent on the survey. As the study required human participants, ethics clearance was required to perform the study on UCT affiliated persons. We were granted clearance to access UCT staff members and UCT Students. However, the clearance for access to UCT Students was granted on the day that the survey was scheduled to close. We were unable to target students from certain faculties due to this. The evaluation did not require any identifying participant information and therefore participant information remained anonymous.

To analyze the responses, each scaled-response section from the survey (Usefulness, Ease of Use, Ease of Learning, Satisfaction) will be summarized by calculating each question's mean, median, standard deviation, and the section's median. This will allow us to determine how variable each participant's response is relative to one another. The textual responses will be grouped according to their themes to determine the sentiment of the experience as well as to point out any negative or positive thematic points.

4 RESULTS

In this section we present the results from the evaluation. 25 individuals took part in the evaluation. This resulted in 17 full questionnaires being completed with 8 completed with partial data in the scaled-response sections; this data along with the calculated statistics can be seen in Appendix B Tables C-F. We display the performance of each section and questions below.

4.1 Scaled-Response Sections

In this section, each scaled-response section has a total mean and total standard deviation to determine the overall outcome for that section. A participant response of 1 indicates the strongest negative response, 3 indicates a neutral response, and 5 indicates the strongest positive response to the questions asked.

The responses for Usefulness is summarized in Figure 9. It shows that the median score across all of the asked questions is 4 and the total average mean score for this section is 3.94. This calculation accounts for the missing data by excluding it. The standard deviation among the questions ranged from 0.82 - 1.29 and the total standard deviation for the section being 0.13, meaning that the responses among participants had a low-level of dispersion and were mostly similar. Usefulness describes how valuable or applicable COMR is for their use case.

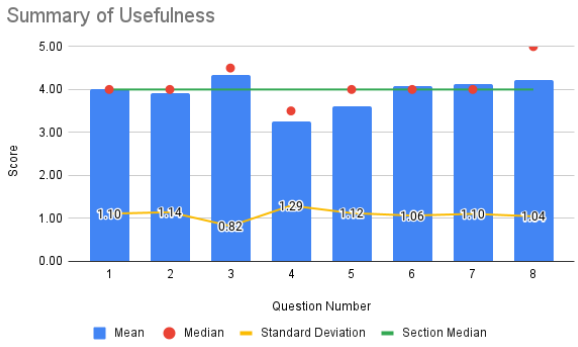

Figure 9: Summary of the participants decisions over the usefulness of COMR

The responses for Ease of Use is summarized in Figure 10. It shows that the median score across all of the asked questions is 5 and the total average mean score for this section is 4.41. This calculation accounts for the missing data by excluding it. The standard deviation among the questions ranged from 0.68 - 1.27 and the total standard deviation for the section is 0.20, meaning that the responses among participants had a low-level of dispersion and were mostly similar.

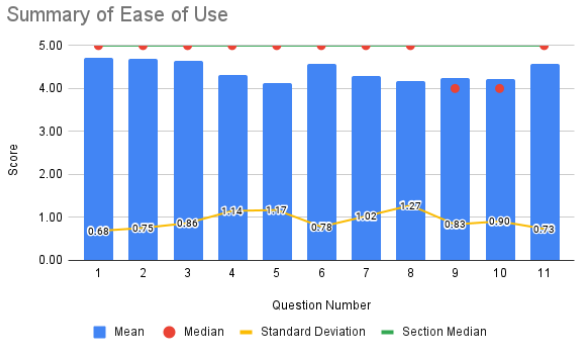

Figure 10: Summary of the participants decisions over the ease of use of COMR

The responses for Ease of Learning is summarized in Figure 11. It shows that the median score across all of the asked questions is 5 and the total average mean score for this section is 4.59. The standard deviation among the questions ranged from 0.74-0.96 and the total standard deviation for the section is 0.10, meaning that the responses among participants had a low-level of dispersion and were similar.

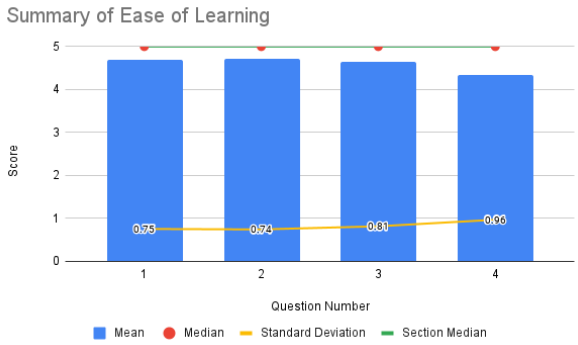

Figure 11: Summary of the participants decisions over the ease of learning of COMR

The responses for Satisfaction is summarized in Figure 12. It shows that the median score across all of the asked questions is 4 and the total average mean score for this section is 3.87. The standard deviation among the questions is ranged from 0.79 - 0.82 and the total standard deviation for the section is 0.15, meaning that the responses among participants had a low-level of dispersion and were similar.

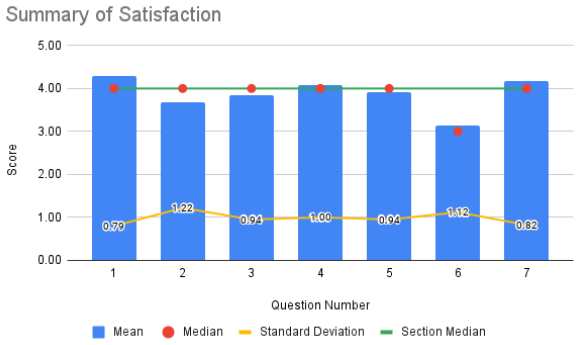

Figure 12: Summary of the participants decisions over the satisfaction of COMR

4.2 Textual Responses

The results in this section are from data in Appendix B Table G. Each response has been coded accorded to a theme which will be discussed in the following section. Appendix B Table G, shows the coded themes for each of the participant responses. Responses were encoded in terms of major topics within the response and whether it reflected a positive or negative sentiment.

5 FINDINGS

5.1 Usability

It appears that the experience of using the tool is positive and usable. Each section in the questionnaire had a median score of 4 or above, indicating that the participants found COMR a usable and understandable experience. Table 1 below shows a comparison of median scores across the sections.

Table 1: Summary of the total median score across each section

Section	Median Score	Standard Deviation
Usefulness	4	0.13
Ease of Use	5	0.20
Ease of Learning	5	0.10
Satisfaction	4	0.15

It should be noted that the Usefulness sections average score was 3.94. This is unexpected as the Ease of Use average value was much higher at 4.41. The expected case was for the Usefulness and Ease of Use score to be more closely aligned [19]. However, this is likely due to participants not belonging to the target demographic, or having practical value for it. COMR poses an interface that is simple and easy to use. The "Favourable Positive" and "Simplicity Positive" categories in Appendix B Table G. highlight the number of responses that support this claim, which also aligns with the Ease of Learning section. The absence of assessments completed by specialists in the User Design and Historical Studies fields may give the false impression that the final product is of lower/higher quality than it actually is.

5.2 Features

Overall, the "Desiring" and "Lack of Features" categories in Appendix B Table G, suggests that participants found the current map viewing experience basic and not complex enough, and that more features should be included. The following subsection will discuss the responses pertaining to positive and negative feedback for the features drawn from the evaluation.

5.2.1 Negative Responses.

Zooming and Panning. Responses for this feature can be viewed in the "Zoom and Panning Negative" category in Appendix B Table G. Participants found that zooming was either unnecessary or too extreme. The zoom feature had no discoverable cues on the interface. It was mapped to the mouse's scroll wheel. Participants may have found zooming to be extreme due to not having a zoom level or zoom activation indicator on the interface. The zoom feature is also highly sensitive and there is no maximum or minimum zoom level. It was also discovered that, through the evaluation, we did not account for users with trackpads. One participant reported *"my trackpad was sensitive and kept zooming in and out."*. This acknowledges two issues; users with trackpads will have difficulties zooming in and out; users with trackpads that are not aware of the gesture for zooming, or those who do not have a trackpad with a dedicated scroll bar will not be able to use the zoom. A zooming indicator, and, minimum and maximum zoom limits should be implemented. Buttons for zoom controls should also be implemented to aid those without a convenient or easily accessible method of activating the scroll-bar or scroll-wheel with a trackpad or other input device. One participant pointed out that the zoom/pan feature may be unnecessary and that the map should be in a fixed position: *"Maybe having the map diagram fixed in the viewing stage."* It is possible the maps participants evaluated were not large or complex enough to optimally make use of a zoom feature.

Lack of Colour and Poor Layout. Responses for this feature can be viewed in the "Lack of Color/Aesthetic Design Negative" category in Appendix B Table G. COMR offers the map in one colour when not interacted with, and a single colour change on a node when it is clicked on. It largely appears that colour is an important factor when viewing maps. This would need to be implemented on COCE side of MASH and then sent to COMR as COMR does not handle any editing of the maps. It is, however, possible to change the theme of COMR to express more colour e.g. changing the colour of the header, or the canvas on which the map is drawn. Some participants reported that the current layout was unsatisfactory but did not give enough information to allow us to determine why this was the case or what their reasons were. One participant reported: *"maybe make the colours a bit more catching More engaging and fun-to-look-at design of the concept map could be a possible improvement "*. From this, we could infer that the design is basic or not complex enough to stimulate higher levels of interest. Another usability study to specifically realize the issue should be undertaken. One user also reported: *"When in index mode, the search bar should be a bit more visually differentiated"*. This could indicate a difficulty in locating the search bar, as its colour is matches the background of COMR's.

Download Function. Responses for this feature can be viewed in the "Download Function" and "Failure Recovery Negative" category in Appendix B Table G. One participant pointed out that the download button for the map should be on COMR itself and not as an option on COCE. This could indicate confusion when this participant attempted to complete the "Download a map task". A download button should then be implemented on both COCE's dashboard and COMR itself, allowing for choice and convenience. One participant suggested that it was not a useful feature. It could be the case that they did not have a use for downloading the map, whereas someone in a specialized field, such as an archivist or bibliographer, may want to view or store it offline for archival purposes for example. Two participants tried to open and view the downloaded concept map. They both reported that they were unable to view it. This is likely the case as the maps were stored inside a zip archive, and both of the participants attempted to view the map web-page directly inside the compressed folder, rather than extracting the files to view it. This means that for those users with little experience using compressed folders may not be able to effectively use the downloaded version of the map. Instructions for using the downloaded version should be told to the user by either diplaying it on request to download or embedding instructions with the downloaded file.

Relationships and Nodes. Responses for this feature can be viewed in the "Relationships and Nodes Negative" and "Desiring" category in Appendix B Table G. It appears that participants were expecting edges to be interactive as suggested by two responses; *"There is no way to show the nature of an edge relationship "* and *"being able to add descriptions of the edges."*. In MASH, there is no function to add information to the edges, much like the nodes. However, functionality exists for this within the Vis.js library. This would be helpful to implement as it provides additional context for the relationships among the nodes. One participant reported: *" different connecting lines to illustrate loose vs strong relationship"*. This means that the default edges connecting nodes together do not immediately display any information about the relationship among them. This would also be helpful to implement as it provides additional context for relationship types. This is a prominent concept in Unified Modeling Language[8] (UML) which facilitates modeling the design of a software system[10]. Relationships types and strength among nodes in UML diagrams can be denoted by a change in the shape of the connecting point of an edge. This may prove to be something useful to implement as it does not require any extra effort for the user, such as clicking on an edge to gain more insight into the relationship, when attempting to understand the nature of relationships among nodes.

Accessing COMR. Responses for this feature can be viewed in the "Map Viewing Negative" category in Appendix B Table G. One response suggested that it was cumbersome to have COMR open in a new tab; *"Having to open up a new tab for each map"*. This can become cumbersome for a user if they want to open multiple maps in a session of using MASH, and may lead to their browser tabs becoming polluted with COMR tabs. However, this was a design decision to keep both COCE and COMR active in the event that a user wants to view multiple maps simultaneously. However,

[8]Unified Modeling Language: https://www.uml.org/

an option to open a map in a new tab should be implemented, with a "back" navigation button for traversing back to COCE's dashboard.

5.2.2 *Positive Responses.*

Index/List View. Responses for this feature can be viewed in the "Useful Features Positive" and the "Not useful features Negative" category in Appendix B Table G. The index/list view feature had majority positive and few negative responses. This mixture could suggest that it is not applicable to all users of COMR. It is likely that the maps participants evaluated were not complex enough to make use of the index/list view feature. Users who create or view large complex maps are probably more likely to end up using the index/list view with its search features. This is further emphasized by: *"confusing search mode , don't understand why there should be different search mode"* and *"removing search mode, just searching based on the word provided."* and *"i would like it to show where the keyword searched is found in the article, rather than just showing which node its from"*. The varying control over the search feature is used to combat the search results of concept maps with potentially hundreds of nodes that may have very similar information in each "title" and "description" attributes.

Metapanel and Details Renderer. Responses for this feature can be viewed in the "Useful Features Positive" category in Appendix B Table G. Multiple participants reported that the details renderer and the metapanel features were enjoyable and easy to use and understand. Participants appreciated that within the details renderer it was possible to link to external resources.

6 CONCLUSIONS

The MASH project aimed to determine whether such a tool for creating and viewing interactive concept maps is feasible to implement in a realistic setting, where this paper focused on COMR of MASH. We approached this by conducting a feasibility investigation with 3 specific objectives. Based on the user evaluations, we conclude that it is feasible to implement technically, by demonstrating a working and usable prototype. End users largely understood created outputs, being the concept maps with its corresponding node supplementary information and the interactive points, such as the clickable nodes and details pages, were comprehensible and useful.

While these objectives were met, it does not mean that the developed prototype was perfect. There is room for improvement such as implementing features and ideas mentioned in results and findings. Due to the lack of target user participation in the evaluations, we were unable to assess specifically if this would be a good platform for mapping cultural heritage content, however we can assume that the platform is understandable and usable in a context that is not domain bound.

6.1 Limitations

The project was undertaken during the COVID-19 pandemic, which resulted in user evaluations being conducted asynchronously. Some participants may have skimmed the survey and not paid attention to the questions that could have resulted in less accurate or lower quality data. This is in comparison to in-person evaluations that could improve clarity and accuracy of participants' responses. The team needed to wait for approval to access UCT Staff and Students, meaning that user evaluations were mostly confined to people outside of UCT, as we have received access to UCT Staff but not students. This resulted in fewer participants than desired. This meant that we were not able to evaluate the tool for users from a specific field, but rather for its general use. Some participants' association with the team may have caused them to introduce biases into the evaluation. Some questions were not fully completed by participants, thus negatively affecting statistical analysis on the questionnaire data.

6.2 Future Work

In general, COCE and COMR could be better integrated to allow for real-time editing of created maps. This would allow end-users to perceive more control over what they create as they are able to visually see the changes in real-time. In addition to editing the aesthetics of COMR should also be taken into account as this was a desired feature as supported by the evaluations. This could also negate the "basic" feeling some participants reported. The download function can be redesigned, to allow for the downloaded view to mimic the online view, unlike the current inline display of details implementation. This can be done by generating the details pages on the client-side rather than server side, or, redesigning COMR to allow for statically embedded resources rather than dynamically inserted resources. Aside from reported participant feedback, collaboration features would be beneficial to teams of users and support for other device platforms such as mobile devices.

ACKNOWLEDGMENTS

The author wishes to express his gratitude to the supervisor Dr. Hussein Suleman, as well as the second reader, Mr. Aslam Safla, project partner, Laaiqah Hassim, and the Five Hundred Year Archive team for their help and feedback during the project. The contributions of those who took part in our system review are also valued.

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Appendix A. - Supplementary Information

USE Questionnaire

Section 1: Demographic Information

1. What is the highest degree or level of school you have completed? If currently enrolled, highest degree received?

2. What is your specialization (major subject in tertiary study or work specialization)?

Section 2: COMR

Each question in the table below was accompanied by a Likert Scale ranging from 1-5 where 1 indicates the strongest negative response, 3 indicates a neutral response, 5 indicates the strongest positive response.

Table A. Use Questionnaire

Section	Questions or Response Type
Usefulness	1. It helps me be more effective. 2. It helps me be more productive. 3. It is useful. 4. It gives me more control over the activities in my life. 5. It makes the things I want to accomplish easier to get done. 6. It saves me time when I use it. 7. It meets my needs. 8. It does everything I would expect it to do.
Ease of Use	1. It is easy to use. 2. It is simple to use. 3. It is user friendly. 4. It requires the fewest steps possible to accomplish what I want to do with it. 5. It is flexible. 6. Using it is effortless. 7. I can use it without written instructions. 8. I don't notice any inconsistencies as I use it. 9. Both occasional and regular users would like it. 10. I can recover from mistakes quickly and easily. 11. I can use it successfully every time.
Ease of Learning	1. I learned to use it quickly. 2. I easily remember how to use it. 3. It is easy to learn to use it. 4. I quickly became skillful with it.
Satisfaction	1. I am satisfied with it. 2. I would recommend it to a friend. 3. It is fun to use. 4. It works the way I want it to work. 5. It is wonderful. 6. I feel I need to have it. 7. It is pleasant to use

Section 3: General Response Questions

Participants were then asked the questions below that required participants to enter textual responses:

1. List the 3 most negative aspect(s)?
2. List the 3 most positive aspect(s)?
3. What was the most useful feature?
4. What was the least useful feature?
5. Can you suggest any improvements?
6. What is your overall experience/feedback with this feature of the website?

Appendix B. - Supplementary Information

Questionnaire Participant Responses

Table B. Participant's Level of Education and Specializations for Demographic Information

Participant Number	Highest Level of Education	Specialization
1	High School	Philosophy and Political Science
2	Masters	Historical studies
3	Undergraduate Degree (or 4 Years with Honours)	Accounting
4	Undergraduate Degree (or 4 Years with Honours)	Linguistics
5	PhD	History
6	High School	Chemical Engineering
7	Primary School	Scholar
8	PhD	Urban Studies
9	Undergraduate Degree (or 4 Years with Honours)	Computer Science
10	Diploma	Electrical and Electronic Engineering
11	High School	Medicine
12	Undergraduate Degree (or 4 Years with Honours)	English Literature, Philosophy, and Psychology
13	Undergraduate Degree (or 4 Years with Honours)	Information Systems
14	Undergraduate Degree (or 4 Years with Honours)	Marine Biology
15	High School	Civil Engineering
16	Undergraduate Degree (or 4 Years with Honours)	Electrical and computer engineering
17	High School	Computer Science
18	Undergraduate Degree (or 4 Years with Honours)	Heritage Inventories
19	High School	B.S.c in Computer Science & Computer Engineering
20	Undergraduate Degree (or 4 Years with Honours)	Chemistry
21	Undergraduate Degree (or 4 Years with Honours)	Applied Biology and Ecology & Evolution
22	Undergraduate Degree (or 4 Years with Honours)	biochemistry and genetics
23	Undergraduate Degree (or 4 Years with Honours)	Biological anthropology
24	High School	BSc Computer Science and Business Computing
25	High School	Human Physiology and Anatomy, together with Biochemistry

Table C. Responses Usefulness for COMR

Participant Number		Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8
1		5	5	5	5	5	5	5	5
2		4	4	4	3	4	5	4	4
3		4	4	3	4	4	4	3	5
4		5	5	5	2	4	5	5	3
5									
6		5	5	5	4	5	5	5	5
7		4	4	4	4	4	4	4	3
8		3	3	5			4	4	4
9		2	2	2	2	2	2	2	2
10		4	3	3	1	4	4		5
11		1	1	4	1	1	1	1	5
12		5	5	5	4	4	4	5	5
13		4	4	4		2	3	3	2
14		2	2	5	1	2	4	4	5
15		5	5	5	4	4	5	5	5
16		4	4	4	4	4	3	3	
17		4	4	5			5	5	5
18		4	4	4		4	4	4	3
19		5	5	5	5	5	5	5	5
20		5	5	5	4	4	4	5	5
21		3	3	4	3	3	4	4	4
22		4	4	4	3	3	3	4	3
23		5	3	4	3		5	5	4
24		5	5	5	5	5	5	5	5
25		4	5	5	3	3	5	5	5
Section $\bar{x}$	3.94	4.00	3.92	4.33	3.25	3.62	4.08	4.13	4.22
Section M	4.00	4.00	4.00	4.50	3.50	4.00	4.00	4.00	5.00
Section σ	0.13	1.10	1.14	0.82	1.29	1.12	1.06	1.10	1.04

Table D. Responses for Ease of Use for COMR

Participant Number		Q1	Q2	Q3	Q4	Q5]	Q6	Q7	Q8	Q9	Q10	Q11
1		5	5	5	5	5	5	5	5	5	5	5
2		5	5	5	5	4	4	4	5	3	4	5
3		5	5	5	5	5	5	5	5	4	4	5
4		5	5	5	5	5	5	5	5	4	3	5
5		4	4	4	3	4	4	3	2	4	3	4
6		5	5	5	5	5	5	5	5	5	4	5
7		4	3	4	3	4	3	3	3	4	2	3
8		5	5	5	5	3	5	5	4	5	5	5
9		2	2	1	1	2	2	1	5	3	3	3
10		5	5	4	2	1		4		3		
11		5	5	5	5	5	5	5	5	5	5	5
12		5	5	5	5	4	5	5	2	5	5	5
13		4	4	4	3	2	5	3	2	4	4	4
14		5	5	4	4	3	4	4	3	4	4	4
15		5	5	5	5	5	5	5	5	5	4	5
16		5	5	5	5	3	5	5	5	5	5	5
17		5	5	5	5	5	5	4	5	5		5
18		5	5	5	5	4	5	5	4	4	5	5
19		4	4	5	3	4	4	4	1	2	3	3
20		5	5	5	5	5	5	5	5	5	5	5
21		5	5	5	5	5	5	5	4	4	4	5
22		5	5	5	5	5	5	3	5	4	5	4
23		5	5	5	5	5	5	5	5	5	5	
24		5	5	5	4	5	4	5	5	5	5	5
25		5	5	5	5	5	5	4	5	4	5	5
Section $\bar{x}$	4.41	4.72	4.68	4.64	4.32	4.12	4.58	4.28	4.17	4.24	4.22	4.57
Section M	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	4.00	4.00	5.00
Section σ	0.20	0.68	0.75	0.86	1.14	1.17	0.78	1.02	1.27	0.83	0.90	0.73

Table E. Responses for Ease Learning for COMR

Participant Number		Q1	Q2	Q3	Q4
1		5	5	5	5
2		5	5	5	4
3		5	5	5	4
4		5	5	5	5
5		4	4	4	4
6		5	5	5	5
7		4	4	3	3
8		5	5	5	5
9		2	2	2	2
10		5	5	5	
11		5	5	5	5
12		5	5	5	5
13		4	5	4	2
14		5	5	5	5
15		5	5	5	5
16		5	5	5	5
17		5	5	5	5
18		5	5	5	4
19		5	5	5	5
20		5	5	5	3
21		5	5	5	5
22		5	5	5	5
23		3	3	3	4
24		5	5	5	4
25		5	5	5	5
Section $\bar{x}$	4.59	4.68	4.72	4.64	4.33
Section M	5.00	5.00	5.00	5.00	5.00
Section σ	0.10	0.75	0.74	0.81	0.96

Table F. Responses for Satisfaction for COMR

Participant Number		Q1	Q2	Q3	Q4	Q5	Q6	Q7
1		5	5	5	5	5	4	5
2		4	4	3	4	3	2	3
3		5	5	4	5	4	3	5
4		5	5	5	4	5	3	4
5		4	4	3			3	4
6		5	4	5	5	5	5	5
7		4	4	3	3	3	2	4
8		4	3	4	2	3	3	5
9		2	1	3	2	2	2	2
10		4	2	2				
11		5	1	3	5	3	1	3
12		5	5	5	5	5	3	5
13		3	2	2	3		3	4
14		4	3	4	4	3	2	4
15		5	5	4	5	5	4	5
16		4	3	3	3	3	3	3
17		5	3	5	5	4	1	4
18		4	4	4	3		4	4
19		4	4	4	4	4	4	4
20		5	5	4	5	5	5	5
21		4	3	3	4	4	3	4
22		5	4	5	5	4	3	4
23		3	4	4	4	3	3	4
24		5	5	5	5	5	4	5
25		4	4	4	4	4	5	5
Section $\bar{x}$	3.87	4.28	3.68	3.84	4.09	3.90	3.13	4.17
Section M	4.00	4.00	4.00	4.00	4.00	4.00	3.00	4.00
Section σ	0.15	0.79	1.22	0.94	1.00	0.94	1.12	0.82

Each participant's response is separated by a new line or by an empty line space to denote multi-line responses.

Table G. Responses for Ease of Use for COMR

Theme	Participant Response
Zoom and Panning Negative	*The zoom in and out function in the viewing stage felt extreme* *Zooms in/out too much on the map* *Zooming in and out* *The zoom in and out function in the viewing stage, when you're not editing, can make navigating a little chaotic* *moving the diagram around* *Using the mouse wheel to scroll on the page would at times conflict with the function to zoom in on the mind map* *Zooming in* *my trackpad was sensitive and kept zooming in and out.* *It zooms too far in and out.* *Sometimes i find myself loosing the mindmap by mistakenly scrolling and it getting very small. Would be nice to implement a button that brings it back to normal size in the centre of the screen* *Zooming in and out when nodes are a good viewable size.* *It isn't necessary to have the zoom feature so prominent* *I think the zooming in and out with the trackpad can be simplified to a button, as it can hinder the viewing process if you have a sensitive trackpad.*
Lack of Features Negative	*Limited features* *It is pretty basic* *very basic structures* *The relationship didn't display when the edge was clicked as I expacted.*
Lack of Color/Aesthetic Design Negative	*Unable to Colourise the Mind Map* *No other colours* *It does not allow colors* *Use more colour* *having more options in terms of editing the aesthetic of the map (colors etc.)* *Different colours to use for the different heritage aspects to show even more connections.* *Dull* *Boring* *Add color options* *Design layout* *could add the options of more colours to the map* *When in index mode, the search bar should be a bit more visually differentiated* *The colours are all the same* *The nodes just had a title and seemed kind of bare.* *Lack of colour* *inconsistent fonts* *More aesthetic UI* *Provide some colour.* *Cosnsistent fonts* *I think adding colour to the nodes would add a new layer of depth to the maps.* *maybe make the colours a bit more catching* *More engaging and fun-to-look-at design of the concept map could be a possible improvement.*
Download Function Negative	*Download button could be on the map instead of the dashboard* *Downloading the map to view in offline mode.*
Not useful features Negative	*List View* *Index view* *Zooming in and out* *I have to view the map online in order to view in list index* *When in index mode, the search bar should be a bit more visually differentiated* *confusing search mode , dont undersatnd why there should be different search mode* *Index View* *search mode* *When searching for a specific node, don't show all the nodes that are not related to the node being searched for.* *removing search mode, just searching based on the word provided.*

Relationships and Nodes Negative	*There is no way to show the nature of an edge relationship* *The description could be adjusted with the elements* *Unclear if multiple maps can be linked together as a macro map with sub-components* *being able to add descriptions of the edges.*
Map Viewing Negative	*Having to open up a new tab for each map* *Maybe having the map diagram fixed in the viewing stage.*
Simplicity Positive	*Easy to use* *Simple to use* *Very simple and straight foward to use* *It is very easy to use* *Basic design* *It is very legible* *Easy navigation* *How easy it is to use* *the design makes the application very easy.* *Easy to use* *Clean appearance* *I truly appreciate this and through its simple and easy to use design* *very well structured, all relevant info is there and easy to find* *It was very good and user frienfly, enyoyed using it.* *Provides dense information in a concise manner* *its very easy to use* *Easy to use and to navigate through* *the display of the map for me to take in the data*
Favourable Positive	*I found it promising but I hope there is more to come on this* *Overall a good experience!* *think all features are essential at this stage.* *Not sure it has any features that aren't useful.* *Quick and convenient* *Great and easy to use* *It is basic and convenient.* *Very good experience* *This is pleasent to use and easy as it is very user friendly* *It is a pretty user-friendly interface.* *Very helpful* *Quick learn process to learn about our heritage* *It is intuitive in its use* *Decent* *It is well made and I enjoyed using it* *works very well, easy to use and informative* *Very simple to use* *organized* *Good experience.* *All in all, it works as i wished it would and is a seamless program* *I find the functionality quite impressive* *I enjoyed using this feature when concept maps were provided to me. It showed a clear representation of the capabilities of the website.* *It is really good. I am pleased* *The website is pretty* *The layout was easy to understand and gave a good overview.* *I have no suggestion, I'm content* *it was a positive experience, i would the feature quite useful while using it* *I find it positive, if I have the opportunity to use it in the future I would* *I think the website is very innovative and quite useful. The ability to create your own maps that are description dense or light is very useful. I think it has many uses to it apart from explore typically historical settings like family trees and the history of South Africa.*

Useful Features Positive	*The "change to index" function, and the search feature as well.* *The change to "index and search" feature* *The "explore more" link for additional info* *The description on the side* *Being able to zoom in and out of the map* *Linking to external websites* *Having pictures in descriptions* *Viewing Description and content* *The information provided in each area are very detailed, especially with the linking to other websites* *Being able to view saved map* *The possibility of clicking on and learning about the nodes and their specific details* *blocks light up when you click* *Search feature* *Displays brief statement nicely.* *Provides a link for extra information.* *Search function* *Easy to Zoom in and out* *Separate views* *Nice feature to learn more about certain topics in nodes* *The "Explore More" function allows for a good deep dive into the details of the node* *list index view is good.* *Index view.* *easy to use* *Nice to download map* *Search function* *The link to the extra information.* *I like being able to search by keyword* *Change to index* *Downloading the map* *This ability to switch between and index and map mode is a nice feature that helps with locating information quite quickly* *Changing the viewing mode* *being able to search the node* *Being able to switch from mind map to a list is present* *The index feature is extremely useful and I like how it open a full article on a new page.* *easily zooming in and out* *The index mode* *The explore more and sorting buttons are extremely useful.* *being able to download the project* *I liked the way the option to expand and learn more about the node beyond the brief description was presented. The way in which it is displayed means that the user isn't bombarded with the broader description and information on the first click but is rather redirected to a new tab.* *The edge feature is also very nice because it allows the user to make connections on first glance before reading further.* *The index feature which allow as items to be taken* *I think the explore and index mapping feature are most useful as it always you to view the information in a different style.* *searching bar for a node*
Desiring	*More functions* *Add a sides note block, for stuff not important enough for the topic and still need to be included* *Average, it needs improvements* *Limiting* *Needs more colour* *i would like it to show where the keyword searched is found in the article, rather than just showing which node its from* *Brief descriptions of each function when you hover mouse over it* *There are some small features that are missing, that will ultimately help to assist in the visualisation of relationships (eg: different connecting lines to illustrate loose vs strong relationships), at the moment all connections are treated the same. Whilst this will work well for simple relationship building, as the relationships become more complex, that nuance can be lost.*

Helpful	*helpful way to receive information about specific topics* *During the first section, it wasn't very clear to me how all of this fits together and how the concept mapping tool could be used to expand on cultural heritage but after working through this section of the questionnaire, I have now come to see the value in such a mapping tool. It offers the opportunity to easily navigate through related topics and to present them in an engaging and interactive manner. I truly appreciate this and through its simple and easy to use design, it made the experience an enjoyable one.* *I thought it was well designed and responsive. Aside from its use as a concept mapper, it has good potential as a mechanism for distribution of information in a manner that assists viewers to understand the relationship between the concepts* *easy its way of me remembering information* *Provides a clear demonstration of the purpose of such concept maps* *Time saving and very easy to use. loved it*
Failure Recovery Negative	*I could not open the offline version.* *Can't seem to view the downloaded version of the map; not sure if it only a problem when I try it.*