

JSON Based Interactive Online Concept Mapping Tool: *CmapEditor*

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Abstract— Concept Map is popularly known as a knowledge representation tool or knowledge visualization tool. The existing tools support creation of maps with different features but are found to be lack of many basic features. To mention a few are interactivity, scalability, hiding/expanding the submissive concepts and availability. Most of the tools are not accessible online as they are standalone tools. Hence, simple yet interactive tools with improved features would be highly appreciable today. This paper explains the attempt made to develop an online software namely *CmapEditor* for interactive concept mapping and was developed using Java Servlet pages, Java Script and Java Script Object Notation. Further, the tool was evaluated in order to determine whether or not it is useful and creates a positive impact among the users.

Index Terms— Concept Map, Software Design, *CmapEditor*, JavaScript Object Notation (JSON), Interactive Tool.

I. INTRODUCTION

Concept map (CM) is a graphical tool that helps in organizing and representing our knowledge. CMs include concepts, usually enclosed in circles or boxes of some type, and relationships between concepts indicated by a labelled arc that links two concepts where the words on the arc specify the relationship between the two concepts. The founder of CM Novak [1] defines CM “as a perceived regularity or pattern in events or objects, or records of events or objects, designated by a label”. CMs are also known as knowledge visualizers. According to the study [2], CMs have been widely used in many disciplines. To name a few; education, knowledge management, software engineering and many others. CMs have been used in school education for both teaching and learning processes. Recently, researchers started using the CMs for assessment [2 & 3] activities along with or replacing traditional assessment methods. Many researchers have reported the usage of CMs in knowledge management activities like knowledge representation, knowledge acquisition and training as a means of capturing and representing knowledge and applications of CM to different domains across various are reported by Kumar *et al.*, [3].

Today, technology supported learning is catching up everywhere and the rapid growth of Information and Communication Technologies enables software developers to introduce new tools that support more interactive features thus provide better user experience. Introduction of interactive concept maps is essentially viewed as an important progress in terms knowledge visualization that facilitates knowledge

sharing in educational setups.

The focus of this work is on the development of a new concept mapping tool with simple interactive features which are mandatory as well. A novel concept map construction and manipulation tool namely *CmapEditor* is proposed, designed and developed. *CmapEditor* allows the users to create interactive maps for a topic of interest.

As mentioned above, this paper presents the author’s experience in developing the *CmapEditor*. The rest of the paper is organized as follows; section II presents the overview of the existing CM tools in terms of their features, section III analyses the *CmapEditor* requirements, section IV discusses the designing of *CmapEditor*, section V explains the development of *CmapEditor*, section VI presents the evaluation of *CmapEditor* and section VII concludes the paper.

II. OVERVIEW OF EXISTING CONCEPT MAP TOOLS

There are handful of software and tools available for creating and using concept map. The tools are available as either commercial tools or free and open source tools [6]. Most of the tools are stand alone i.e. desktop applications while the few others are online or web based applications. Presently, the concept mapping tools provide features like creating, viewing, storing, editing and sharing the maps and also allow users to collaborate in concept mapping. It is observed that they do not provide interactive features while viewing the maps. In the case of some tools, it observed that loading of the maps to the screen require considerable time.

Further, most of the tools follow own proprietary file formats and modes for storing the map while few others support the standard formats. For example IHMC’s *CmapTool* uses its own format of storing the maps which forces the user to have *CmapTool* installed. Currently, majority of the softwares support both 2D while Microsoft’s 3D *Topicscape* supports 3D concept mapping. Though there are custom developed CM tools and evaluators available, all of them found with lack of support to interactive maps. Interactive maps are kind of maps which allow the users to interact with the map elements. Another tool *Prezi* [7] provides zoom feature over the contents of the map but is used for presentation purposes. The *Prezi* uses an advanced user interface called *Zooming User Interface (ZUI)*. *ZUI* allows users to zoom in and out of their presentation media, and allows users to display and navigate through information.

To summarise, eventhough the existing tools provide essential features to create and manipulate concept maps, majority of the tools do not support interactive features while handling concept mapping activities and portability is not supported as well. Hence, it would be appealing if the following features are included in the tools:

- Navigation among nodes
- Expand /hide nodes
- Trace or track the navigation path

These are considered as the important features for the proposed prototype.

III. SOFTWARE REQUIREMENT ANALYSIS

Any software development process needs to undergo a rigorous requirements analysis process in order to confirm and finalize the functionalities and associated processes. The proposed tool development has also passed through a complete requirement analysis process. As concept mapping was practiced in the classrooms, the author considered suggestions received from the students along with identified functional requirements from the analysis of existing tools. The functionalities like creating a concept map in an online environment, high degree of interaction features, easily editable, scalable etc., were identified. The functional requirements are then categorized based on the core software components like user interface, interactivity, storage mechanism and work environment. Table 1 presents the important functionalities considered.

TABLE 1. FUNCTIONAL REQUIREMENTS IDENTIFIED

Module	Requirements	Description
User Interface	Simple GUI	Simplified graphical canvas that enables the user to create maps by clicking (to create /edit map : add node, add relation, change node / relation. Store / retrieve etc.,)
	Menuless / Buttonless interface	The actions buttons are not used but right click with pop up menu
Interactivity	Tracking of navigation	The path through which the user navigates will be highlighted using a different color in the map (nodes and links)
	Mouseover() actions	Mouse over text as well as image also considered (messages, images, URLs etc.,)
	Simple Animations	When the size of the map grows, the hide node and expand node actions etc.,
	• Hide nodes	
	• Expand nodes	
	Drag and Drop option	Functionality that enables the user to drag and drop the map anywhere inside the canvas.
	Text Manipulation	Font size, style and color and others
Storage format	JSON array structure	Light weight but fast accessible format
Work Environment	Online (Internet/Intranet)	Web application

Another feature identified is dynamic resizing of the map, i.e. the map must accommodate more number of nodes in restricted canvas size and allow the user to navigate easily within the canvas. Few requirements are collected from the students during the brainstorming sessions that were conducted initially. The students wanted the tool as online tool thus can be accessed anytime from anyplace. Another feature considered is portability which is also considered. Several possibilities exist

for achieving the desired portability.

In order to document the identified requirements, simple procedures are developed based on standard software engineering guidelines. The identified functionalities are recorded as functional requirements of the tool and a detailed software requirements specification (SRS) is prepared.

IV. ARCHITECTURAL DESIGN OF CMAPEDITOR

Generally, an architectural is essential for the successful implementation of any software development activity. Wikipedia [8] quotes the description of Clements *et al.*, on software architecture as “the high level structures of a software system”. A three tier architecture is developed which is presented below in Figure 1. The following elements were considered for inclusion into the architecture: the database server, the client application and the application server.

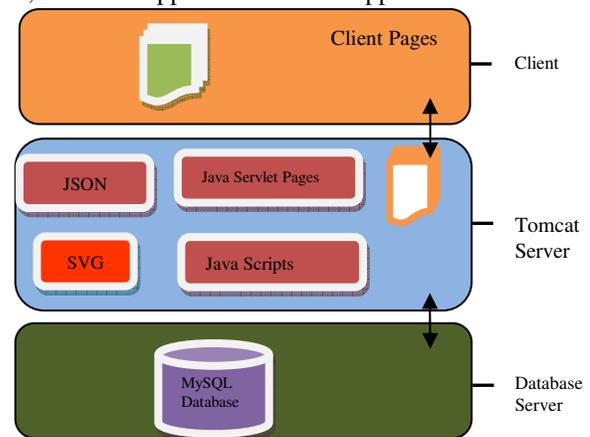


Figure 1. Three tier architecture of CmapEditor

The architecture is implemented by using the following elements: Eclipse Juno, Apache Tomcat, MySQL, Java Server Pages (JSP) and Java Scripts(JS). Apache was chosen as web server which is a container of servlets. A servlet is a small Java interface, which runs within a web server. Servlets receive clients’ requests and respond to them across Hyper Text Transfer Protocol. The servlets can respond to any type of request and they are commonly used to run the web applications of Web servers. Apache also supports PHP and MySQL for web applications to be hosted. MySQL supports JSON as a data type thus enabling the tool to store the contents of the map as JSON array elements.

The node –arc type maps need a hierarchical JSON data structure [4,5]. The JSON is used in web applications to represent data in various styles such as arrays, arrays with objects, objects with nested arrays etc. A schema is needed to handle different types of usage of JSON technically. A custom JSON schema is defined for this tool which is presented below in Table 2.

It presents the definition of a JSON data structure which is used as a schema to represent the nodes, relations, hierarchical levels, submissive concepts and path information. The data from the interface are directly stored into the database as JSON array. Viewmap() function will fetch the corresponding JSON

data and then draw the map for the user to view. With support for nested arrays and objects, JSON can be used to create custom and flexible schemas that needed to store and transport data in a way based on the needs. It is convenient to use a flexible format that isn't restrained by a two-dimensional, table-oriented paradigm.

TABLE 2. JSON SCHEMA & CUSTOM SCHEMA DESIGNED FOR CMAPEDITOR

Simple object	Custom JSON sechema for Concept Map
<pre>newObject = { first: "Jimmy", last: "James", age: 29, sex: "M", salary: 63000, registered: false }</pre>	<pre>var jSon = { id: 'node1', name: ", rel: ", children:0, step: 1, path: 1, nodes: [] };</pre>

V. IMPLEMENTATIOB OF CMAPEDITOR

As discussed, the *CmapEditor* was developed to provide the basic functionalities needed to create and manage concept maps. The functionalities such as add node, add relationship, change node name, change relation name, remove node, remove relation and save are implemented. As mentioned eariler, the *CmapEditor* was implemented using JS, JSP and MySQL technologies. Further, the editor was designed to have the advanced user interface techniques like drag and drop of objects in the canvas. The interactive features like hiding the nodes , expanding the nodes were implemented as they make *CmapEditor* as special one. For example, if the map contains three child nodes under the root node and if the user is navigating through the first child node, then the child nodes of other two nodes are hidden. This enables the user to have a comfortable view of the nodes and links of the map.

Below are features that were incorporated into the CmapEditor.

- No standard menus and buttons
- Context Menu to create and manipulate maps
- Quick display of maps
- Customization functions (brightness, shape and color and etc.,)
- Simple animated features like Hide/expand nodes and Drag
- Supports to text, image and other features (mouse over message, embedding images /url etc.,)

A screen shot taken while creating a map using the CmapEditor is presented in Figure 2.

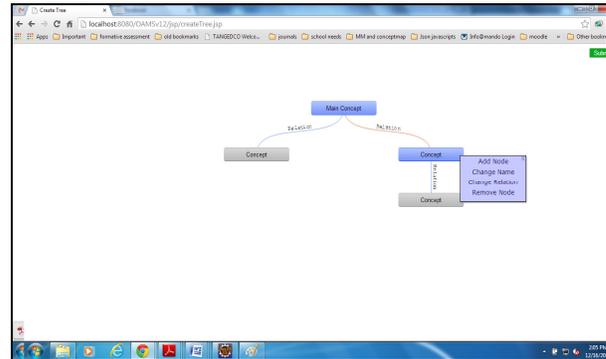


Figure 2. A screen shot taken while creating a map using the CmapEditor
A canvas is created as drawing area where the map is drawn in for this purpose and a Scalable Vector Graphics (SVG) object, a Rounded Rectangle, was chosen for representing nodes of the map and a directed link(arc) drawn to connect the nodes. These objects are defined as dynamic objects as the number of node increases the nodes will be reorganised dynamically (repositioning the map in the canvas)

A screen shot of the concept map created using the JSON structure and SVG objects is shown in the Figure.3.

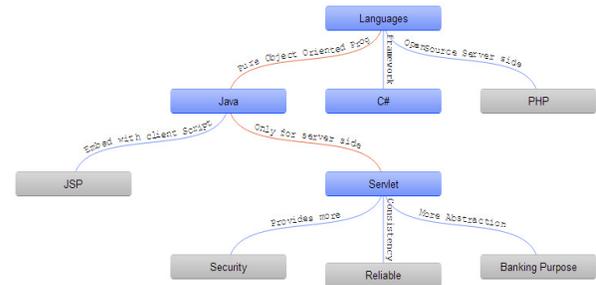


Figure 3. Screenshot of CmapEditor displaying the map created

The standard software testing techniques were involved to verify and validate the tool. Necessary changes were made based on the reports of different test cases.

VI. EVALUATION OF CMAPEDITOR

To evaluate the implemented CmapEditor, a study was carried out with 36 post graduate students from fourth semester. The students have prior experience in using the concept maps and concept mapping tools in their learning and assessment activities. All 36 students practiced concept mapping for a course by name Software Engineering. The methodology used is composed of a survey questionnaire and evaluation based on the use requirements. This methodology was chosen because this experiment involved purposive sampling (Patton) of students. This experiment design involves the definition of a hypothesis that is tested using the selected purposive sampling group. The students were introduced with the CmapEditor and were given enough training to practice the tool. Then, the students were asked to use the tool during their learning and assessment activities. At the end of the practice, the students were issued with a survey questionnaire. The question items in the questionnaire were developed in way that obtain the views of the students about the functionalities of the tool such as the

interactive features, editing of map, access to the map (i.e. storing/ loading of maps to/from the storage). At the end of the survey administration the data were analyzed using probabilistic techniques to validate the initial hypothesis. The hypothesis for this experiment is as follows: “The students value the use of CmapEditor as a simple interactive concept mapping tool”. From such a hypothesis, a dependent variable is defined: “The impact of the use of CmapEditor for concept mapping”. To ensure this a survey questionnaire was circulated to the students. The questionnaire followed a five point Likert scale levels i.e. 1=Strongly Disagree, 2=Disagree, 3=Neutral, 4=Agree, 5=Strongly Agree.

Table.3 shows the question items developed for the survey questionnaire along with the responses from the students (in percentile).

TABLE 3. SURVEY QUESTION ITEMS WITH RESPONSES

Sl. No.	Question Item	SD	DA	NTL	A	SA
1	CmapEditor’s interactive features are very useful	0.0	2.8	5.6	44.4	47.2
2	I like the new interactive CmapEditor very much	0.0	0.0	8.3	33.3	58.3
3	I can track my navigation path in the map	0.0	5.6	2.8	61.0	30.6
4	Interactive CmapEditor helped me to do concept mapping quickly	0.0	2.8	8.3	52.8	36.1
5	The CmapEditor loads the concept maps quickly	0.0	5.6	8.3	47.2	38.9

The survey questionnaires were circulated to all the students and collected back. The responses of the students were analyzed using simple statistical measure mean. The mean value of the individual question items were 4.4, 4.3, 4.1, 4.1 and 4.1 respectively. This shows that the CmapEditor created a positive impact among the students who used it during the experiment. Figure.4 visualizes the survey results as graph. Out of 36 students about 91.6 % of the students have agreed/strongly agreed that the interactive features are useful, in addition to this about 5.6 % students have recorded neutrality for the same item while 2.8 % did not agree that the interactive tool was useful.

The second item was to obtain the view of the students whether they like the tool or not. For this 91.6 students responded positively while 8.3 expressed their neutrality. The third item was about the track path feature of the tool. About 91.6 % students agreed or strongly agreed and 5.6 responded negatively. Further 2.8 % of the students have expressed their neutrality for this item. 88.9 % students agreed or strongly agree that the tool helped them to create the map quickly. 8.3% of the entirety shown neutrality while 2.8 % responded negatively.

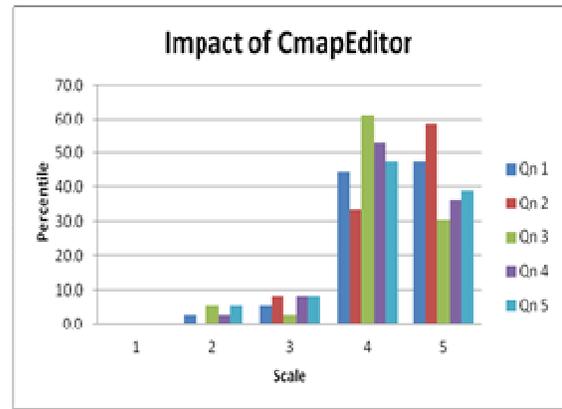


Figure 4 . Students’ view on the impact of CmapEditor

The fifth item was to obtain the feedback on performance of the CmapEditor especially in loading the maps. For this 86.1 % of the students positively responded while 5.6 % students responded negatively. At the same time 8.3 % of students expressed neutrality for this item. Overall, the results showed that the CmapEditor had created a positive impact among the students an interactive concept mapping tool. Hence, The hypothesis is accepted as the result of the survey is favorable towards a positive impact among the students. It is observed that most of the students were appreciating the interactive features in viewing the maps and therefore, it can be affirmed that the hypothesis is correct.

To support this conclusion, an opinion statement was posed to the students. This assertion was: “After using the CmapEditor, I believe that interactive concept mapping tool like this, makes it easy for me to create and manipulate concept maps. Therefore, I prefer CmapEditor for concept mapping and it is more attractive, in my opinion”. A total of above 90% of the students agree with this assertion and consider it useful. Several semi-structured interviews were conducted to take into account the educators’ opinions. During these interviews, the system is presented to them, and their opinions were elicited. The results show that 77% of the educators agree with the functionalities of CmapEditor improve student participation and enrich learning. The other 23% believe that it may not easy to involve concept mapping (CmapEditor) for all courses.

VII. CONCLUSION

A JavaScript and JSON based online concept mapping software tool – CmapEditor is designed and developed. The interactive features are very useful in motivating students as they get excited while navigating through nodes of map. By using JSON based maps, CmapEditor provides a better support to higher education setups that uses concept maps to create, share and assess knowledge. Further to this, the tool was evaluated based on the impact created by the tool using a survey questionnaire and semi interviews with educators and students. Although the results of the preliminary evaluation are favourable, it would be interesting to explore new research avenues in future that focus on 1) including JSON based CMs into the teaching-learning processes, new possibilities for

visualization and inspection of knowledge can be explored in order to improve the teaching-learning process, 2) further evaluation with all stake holders and 3) on the integration of CmapEditor into Modern Learning Management Systems.

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