Learning from Web Searching: Enhancing Users' Experiences with NaviWeb Mobile System

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ABSTRACT: *Retrieving web information and tailoring it to fit users' needs is a challenge for modern web search engines. Most display information from searches the same way, regardless of the user's needs, interests, or context. This is a weakness for mobile users who expect to adapt results and more flexibility in interacting with the information retrieved. This research presents the development of NaviWeb, a multimedia retrieval mobile system that displays multimedia information retrieved from the web through an original and disciplined Graphical User Interface. The system enhances users' search experiences by providing an original way to stimulate learning and captivate their interest while searching the web. Sessions are recorded and managed to comply with the requirements of adaptive mobile learning. NaviWeb has been developed on the Android mobile platform and has been evaluated using a set of metrics. Most users were interested in getting deep knowledge about their initial queries and were keen to resume their previously saved sessions.*

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1. Introduction

Developing comprehensive mobile learning systems that adapt to the user's context and information needs is a real opportunity nowadays. These systems are designed to accelerate skills training and provide direct assistance at critical times. Context-aware learning systems typically rely on sensors to survey the situation on the ground, activate the appropriate modules, and send relevant instructions to the learner at the right moment. This method has been proven to be more effective than traditional teaching programs, and it can be deployed without the extensive need for specialized hardware [1], [2], [3], [4], [5]. Context-sensitive systems are highly flexible and automatically adjust to the needs of every individual learner. That would be impossible for a human, who would have to spend a lot of time working with every learner individually. In that sense, advanced tools of this kind have the potential to increase the capacity of educational institutions, as they serve as force multipliers that allow a small number of instructors to handle large groups of learners. The technology layer that connects educators with their beneficiaries is designed to simulate the instructor's presence on the spot and to provide continual guidance remotely [6], [7], [8].

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It is indisputable that the learning scene is undergoing a radical transformation in the light of technological advances. This process has been driven by greater flexibility and cost-effectiveness of digital learning systems. Mobile technology, in particular, has been disruptive, enabling learners to participate in group work and complete research tasks outside of the classroom. Researchers developed many learning applications, some of which achieved impressive results in deep learning and skills training. Most of those applications use multimedia to stimulate learning and support collaborative work on shared projects. While traditional learning methodologies mostly embrace technological improvements, they still rely on outdated programs and knowledge assessment methodology. It would be difficult to argue for the total overhaul of the established system at this time mobile learning methods are primarily untested and have to be verified before the industry can adopt an utterly digital outlook. For this reason, it is essential to follow the outcomes of ongoing experiments with digital learning systems and m-learning tools. Interactive multimedia will almost certainly continue to gain importance for learning applications, as it affords an opportunity for multi-channel learning that greatly benefits visually inclined learners. Since interactive applications are more engaging than classic teaching materials, learners are more likely to use them enthusiastically of their own free will. Improved motivation leads directly to better learning results, as well as more active participation in group work [9], [10], [11]

This research aims to develop a mobile system that leverages mobile users' experience while searching the web, from a simple information search for an organized learning activity. Instead of simply browsing the web through the list of results provided by a search engine, the system offers a hypermedia presentation of information that adapts automatically to the user's needs and allows him to navigate in a rich structured learning environment. A sophisticated Graphical User Interface does it typically (GUI) generates a learning environment on demand using a variety of multimedia resources, allowing the user to navigate personalized learning paths through sessions complying with the requirements of adaptive mobile learning.

2. Background and Related Work

In the last years, information technologies have decidedly gone mobile, and all recent applications have been designed to perform well on a small and portable screen. Education-related tools are part of this trend and have given rise to m-learning, which comprises all forms of knowledge/skill building through a mobile device. While practically all digital content can be accessed with a mobile device, some applications have been created specifically to take advantage of the mobility and convenience of this medium. They represent the foundation for the future development of m-learning [12], [13], [14]

2.1 User Interface Design

The literature of User Interface (UI) design can be divided into two paths: software engineering and human computer interaction. In human-computer interaction, users care about the aesthetic appearance of the UI as an essential part of the interface design [15]. For the UI of the proposed system, the focus is on multimedia results: images, videos, text. The GUI is where the organized multimedia results are displayed.

Norman was one of the first scholars to suggest the software engineering approach of UI design, an innovative method that considers the user part of the system [16]. Regarding the information displayed on the GUI and the thousands of visual information that we are overwhelmed with these days, attention should be given to how such information is identified, recognized, and grouped. Thus, the principles of mobile interface design [17] are helpful for mobile application developers to consider.

Georgiev and Georgieva [18] suggested some navigation and multimedia elements' requirements realize UIs for *m-learning* applications. Regarding the navigation: i) The navigation must be innate, support mobile keyboards, and be located at the top and/or bottom of the screen; ii) Individual screens may be applied to reduce re-visualization of the main menu and submenus. Those screens must be supported by links in the navigation; iii) Large navigation buttons should be designed to work with a stylus or touch screen; iv) Different screen resolutions must be considered so that the application can be displayed on all mobile devices. Requirements for multimedia elements:

1. The text length must be consistent with the size of the screen and not more than three times the height of the screen.

2. Developers must avoid Text horizontal scrolling, and the text should contrast with the background.

3. The image size must be consistent with the size of the screen.

Modern ways of navigation can be applied by considering the mobile screen orientation, which is in vertical mode most of the time. The recommendation is for two fields with navigation at the top and bottom of the screen while the information is placed between them. The proposed system improves upon this paradigm according to the new features of smartphones (see Section 5.1).

2.2 Multimedia Learning Principles

The rapid growth of the mobile industry has increased opportunities to use mobile devices to support learning [19] effectively. M-learning is the next generation of e-learning and can be declared as e-learning on a mobile device. Sarab and Elgamel noted nine benefits of m-learning [20]. The proposed system offers the following benefits: Provides access to content anytime; Supports distance learning; Is well-suited for just-in-time training or content review.

As a novel of Multimedia Learning Principles, Richard E. Mayer [21] has cited 12 principles that form the design and organization of multimedia presentations:

1. Coherence Principle – "People learn better when extraneous words, pictures, and sounds are excluded rather than included."

2. Signaling Principle – “People learn better when cues that highlight the organization of the essential material are added.”

3. Redundancy Principle – “People learn better from graphics and narration than from graphics, narration, and on-screen text.”

4. Spatial Contiguity Principle – “People learn better when corresponding words and pictures are presented near rather than far from each other on the page or screen.” 5. Temporal Contiguity Principle – “People learn better when corresponding words and pictures are presented simultaneously rather than successively.”

6. Segmenting Principle – “People learn better from a multimedia lesson is presented in the user-paced segments rather than as a continuous unit.”

7. Pre-training Principle – “People learn better from a multimedia lesson when they know the names and characteristics of the main concepts.”

8. Modality Principle – “People learn better from graphics and narrations than from animation and on-screen text.”

9. Multimedia Principle – “People learn better from words and pictures than from words alone.”

10. Personalization Principle – “People learn better from multimedia lessons when words are in conversational style rather than a formal style.”

11. Voice Principle – “People learn better when the narration in multimedia lessons is spoken in a friendly human voice rather than a machine voice.”

12. Image Principle – “People do not necessarily learn better from a multimedia lesson when the speaker’s image is added to the screen”.

These principles are interesting as they have been thoroughly studied and experimented and they provide a practical vision for learning content designers to develop mlearning systems. This research benefited from these principles in the design stage of the proposed system, as described in Section 5.

3. Learning Design

3.1 Learning Web

Learning is a process through which specific learning material is exposed to learners. These units, called Learning Objects (LO) in e-learning, are dispensed to learners in a special preorder; they constitute the necessary material to achieve the e-learning course’s objectives. However, the learner can navigate freely within the LOs’ space tree called the Learning Web (LW) [22], [23]. Figure 1 illustrates an example of LW. Different Learners navigate across the learning web composing their personalized Learning Path (LP), which contains the sequence of objects the learner has been exposed to during the learning process. The LP, which includes all the LOs presented to a learner represents his personal learning experience in the LW. Figure 2 illustrates the LP for a specific user.

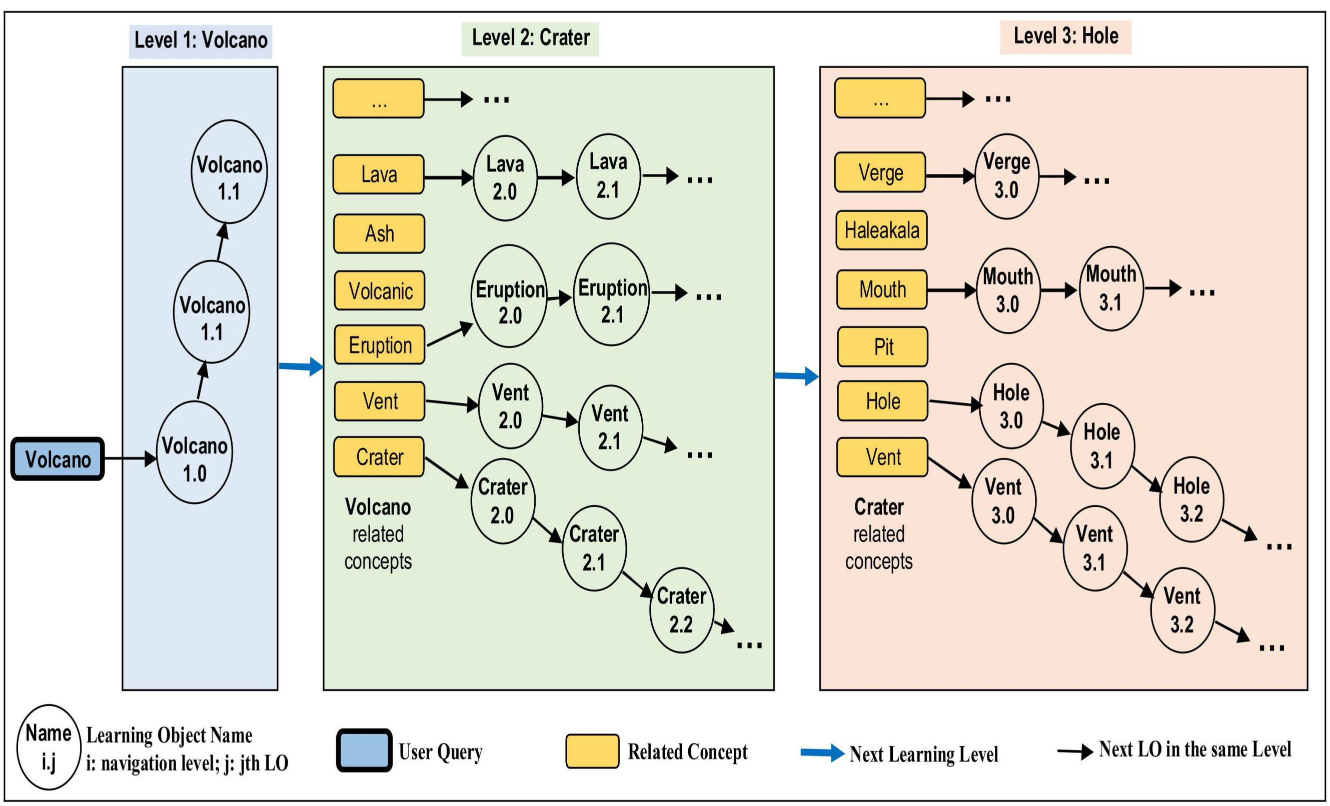

Figure 1. Volcano learning web

3.2. Learning Path

The user navigation is done on the Learning Web (Fig. 1). The user is free to navigate on the LW with no restrictions. Any concept clicked will generate a LO displayed on the screen for the learner. The visited LOs form the Learning Path that represents the learner's personal learning experience. The history of clicked related concepts is stored to keep track of the learner's path. A real-life example of a learning path is illustrated in Figure 2.

The learner path is a treelike structure that exhibits two learning dimensions: the breadth and depth of learning. The breadth is accessed if the user requests more detail about a concept. In this case, he can get more LOs related to the same concept by clicking the "more details" button. The learner may be interested in getting knowledge about related concepts to get more profound knowledge about the current concept. In this case, he clicks on one of the related concepts displayed which takes him deeper into the LW. Figure 1 shows three levels of learning, each level is bordered by a rectangle. A LO is represented as a page displayed to the user containing web resources retrieved by NaviWeb in response to the user request. The LO organizes resources into templates, including text, a video, images, and hyperlinks. The typed query in Figure 1 is "Volcano," which triggers NaviWeb to retrieve the first LO Volcano1.0. The user is at level 1, and he requests more details for this concept "Volcano." The system retrieves resources for this request and displays LO Volcano1.1, which is another LO illustrating the concept of Volcano. Then the user clicks on the "Crater" concept listed among the related concepts of "Volcano" from the upper navigation bar. He will move to the next navigation level (Level 2) with LO Crater2.0. At this level, the user is interested in having more detail about the same concept. By clicking on more detail, he will be exposed to LO Crater2.1. After this, he requests in-depth knowledge related to the concept "Hole" from the upper navigation bar. He will be moved to level 3 to LO Hole3.0. In this level, the user requested two times more detail buttons and the system displayed Hole 3.1 and Hole 3.2 providing breadth knowledge at the same level.

In sum, the session initiated by the query "volcano" produced the learning path in Figure 2, including a depth of 3 levels, including the related concepts ("crater" and "Hole") proposed by the system. For each concept, the user requested more details ending up with breadth navigating within the same level.

4. System Architecture

NaviWeb, the mobile system developed in this research, has been designed to be integrated with three web search APIs (Application Program Interface): Google API, Wikipedia API, and DataMuse API. The architecture can represent a system in the form of three main layers (Figure 3).

1. Presentation layer: Contains the GUI, browser, and the SE (Search Engine).

2. Business layer: Contains query generator, LO composer, and learning management.

3. Data layer: Contains a session manager, query han-

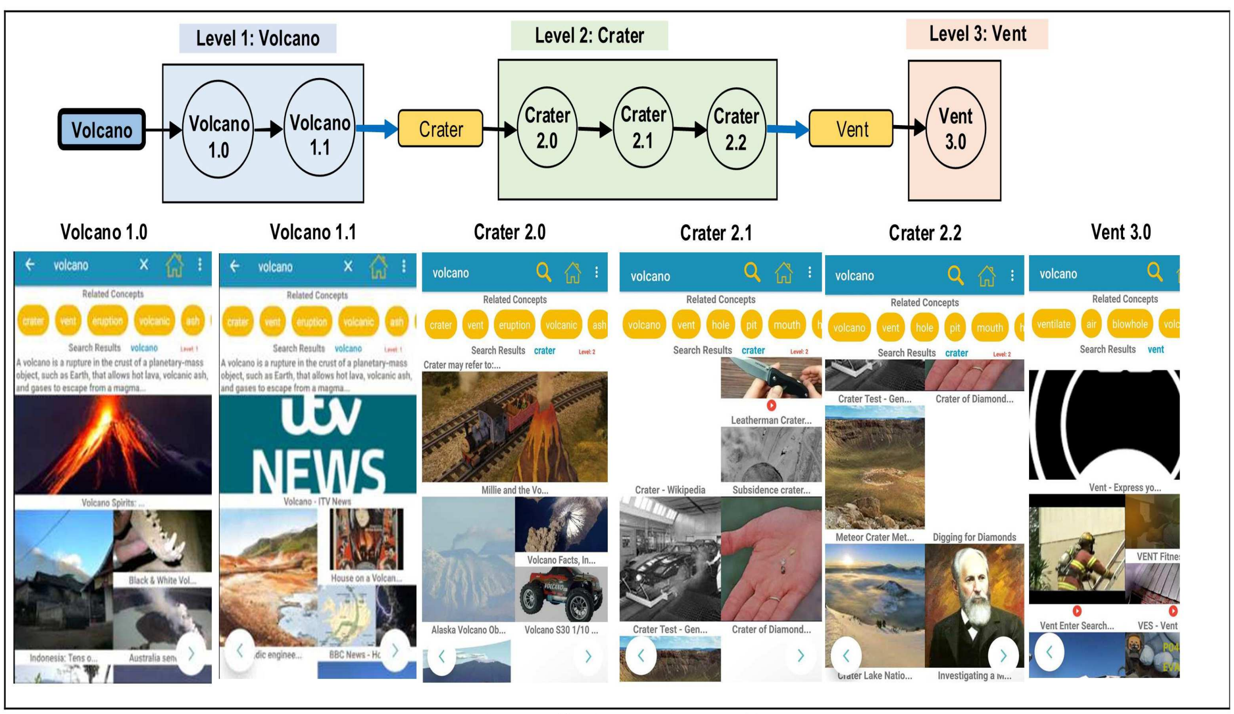

Figure 2. Learning path

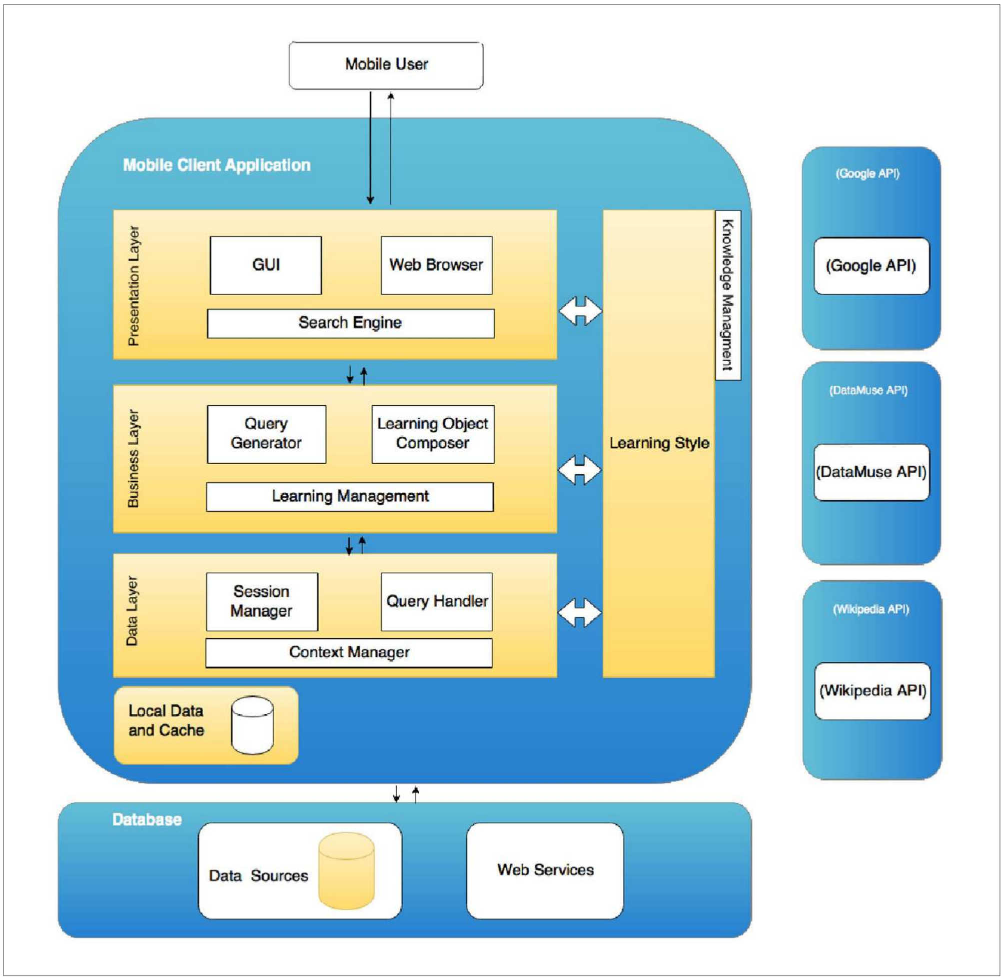

Figure 3. System Architecture

dler, and context manager.

The layers interact with the knowledge management, which forms the learning style. Then all saved LOs are forwarded to the Database to be saved and retrieved whenever the user requests them. Client-server architecture is used to establish the communication process.

The system retrieves the results from the following three web sources to feed the GUI (Figure 4):

1. Related concepts are retrieved from Datamuse (www.datamuse.com), a lexical search service, which retrieves a set of words matching the user query in a given context. These words are displayed in the GUI and are ordered in the upper bar by the most related concept first in descending order. The learner can click any concept he is interested in, which automatically triggers the LO's generation on the mobile screen.

2. Brief text extracted from Wikipedia, to give the user a quick overview about the keyword. If there is no article related, no text will appear.

3. A grid of multimedia results (images and videos) is retrieved from Google SE and is arranged in a semi-smart, well-designed grid that will display the most related item as the main LO. Other LOs follow the latter requested on-demand. Six results will be displayed; the following pages will display ten results. The last step in SE activities is retrieving the best-matched results, known as the SE algorithm; results by relevancy depend on the SE algorithm. The parallel processing that Google uses speeds up data processing, which distinguishes it from other SEs. Furthermore, updating the ranking algorithms by Google may influence the ranking of results, which is out of our control.

As shown in Figure 4, the multimedia information collected is arranged into the GUI to be adapted through the user content.

5. System Implementation

5.1 Implementing Learning Principles in NaviWeb

Applying multimedia learning principles [21] in this research has resulted in the following benefits. Table 1 shows how those principles have been used and applied in NaviWeb mobile system:

Using the seven multimedia learning principles in Table1 has shaped the design and organization of the GUI to be more suitable cognitively for various users. Indeed, users were more engaged with the material, and this was clear at the system evaluation stage (Section 6), where most users showed and enthusiasm in using NaviWeb in their searches.

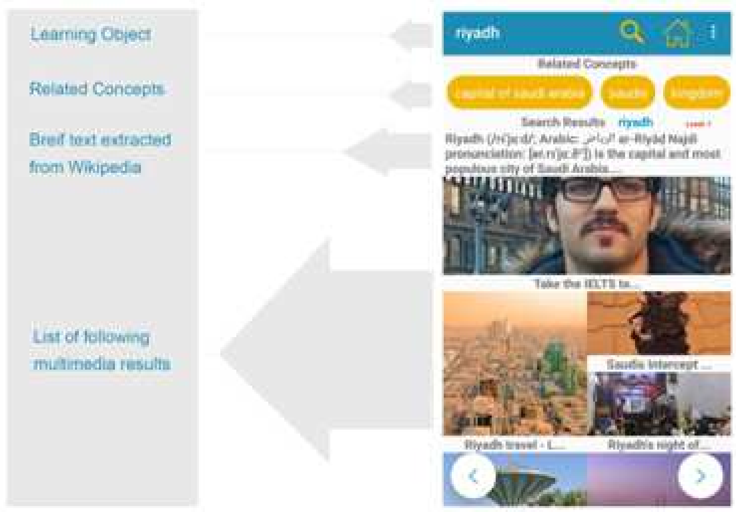

Figure 4. Multimedia Grid GUI

Principles of Multimedia Learning	How it is Applied in NaviWeb
Coherence Principle "People learn better when extraneous words, pictures, and sounds are excluded rather than included."	In NaviWeb, a short text (fewer than 20 words) is presented for each search. Also, only the top videos and images that fit with the screen size will be displayed (around six).
Signaling Principle "People learn better when cues that highlight the organization of the essential material are added."	The GUI provides essential navigation information is added to help organizing the material displayed. The GUI displays the Level representing the depth of the requested information, Related Concepts which represent similar query concepts. Also "back" "forward" and "home" buttons are added to allow the user to navigate freely.
Redundancy Principle "People learn better from graphics and narration than from graphics, narration, and on-screen text."	Graphics and narration that are combined in a video will be streamed to the user on demand without displaying the graphics and on screen text. There is no redundancy, to let the user focus on the video.
Temporal Contiguity Principle "People learn better when corresponding words and pictures are presented simultaneously rather than successively."	The first page presented to the user will be a combination of words, text, pictures and videos corresponding to the same topic. They are presented simultaneously.
Segmenting Principle "People learn better from a multimedia lesson presented in user-paced segments rather than as a continuous unit."	Information is presented as a set of self-contained learning objects presented on-demand. The user is free to navigate through the LOs. Also any user session is stored automatically allowing the user to resume it at any time.
Pre-training Principle "People learn better from a multimedia lesson when they know the names and characteristics of the main concepts."	The name of the current LO (corresponding to the query) will be displayed while the user navigates in NaviWeb. Also, related concepts to the current query are displayed at the top of the screen.
Personalization Principle "People learn better from multimedia lessons when words are in a conversational style rather than a formal style."	Videos shown by NaviWeb are authored by millions of people around the world. They are meant to be consumed by the large public, most of them are in conversational style

Table 1. Multimedia Learning Principles Applied in NaviWeb

5.2 Software Technologies Used

NaviWeb has been developed on the Android operating system for mobile phones. The programming language used during the development stages is Java. Android Studio was the primary development environment. Microsoft SQL Server 2014 was used for implementing the database, and Windows Server was used for hosting the data. There are three types of communication required: using the XML (eXtensible Markup Language) Simple Object Access Protocol (SOAP), communication is established between the mobile application and a web service. This type of communication is done by SOAP, which provides a communication way between different operating systems applications. The other communication is between the mobile application and the three APIs, JSON (JavaScript Object Notation) for Google and DataMuse and XML for Wikipedia. On the webserver, two steps must be done: i) Running the Apache server to run the *Javacode*, so the server accepts the HTTP (Hypertext Transfer Protocol) requests from any android mobile device; ii) Installing Microsoft SQL server to store data in the database tables[24].

5.3 System Management

5.3.1 Search Results

Retrieving results is one of the main functions of the proposed system: with one click, the user will get a grid of pictures, videos, and text with the most related concepts to the query that had been typed and an option to get more details about the query all in a single GUI. The system will retrieve results from many resources that are detailed in Section 4.

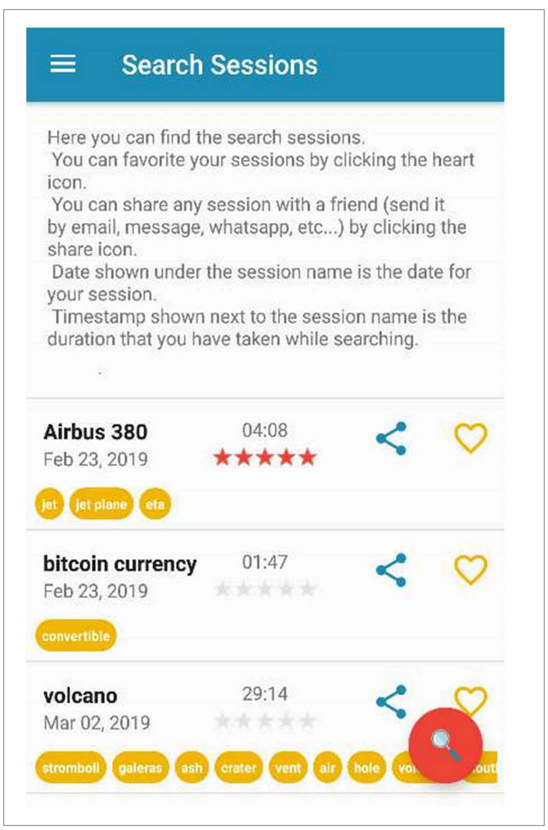

Figure 5. Sessions Page

5.3.2 Sessions Management

Search sessions will be saved automatically to ensure the users will not lose any of their search results and can resume at any time their previous searches. Each session will contain the following attributes:

1. Query search (LO): Placed at the top of the results page.

2. Related Concepts: will be stored as a history of concepts the user clicked on.

3. Time duration of the search: Placed next to the learning object in the session page.

4. Date of the search: Placed at the bottom of the learning object in the session page.

5. Favorite choice: The user can click on the heart icon, which appears next to the learning object, to bring the favorite sessions upward.

6. Share choice: The user can share any of his or her saved sessions with friends by clicking the share button next to the learning object.

7. Delete choice: The user can delete any of saved sessions by long-pressing the learning object.

8. Current Page: So the user can resume from where searching ceased.

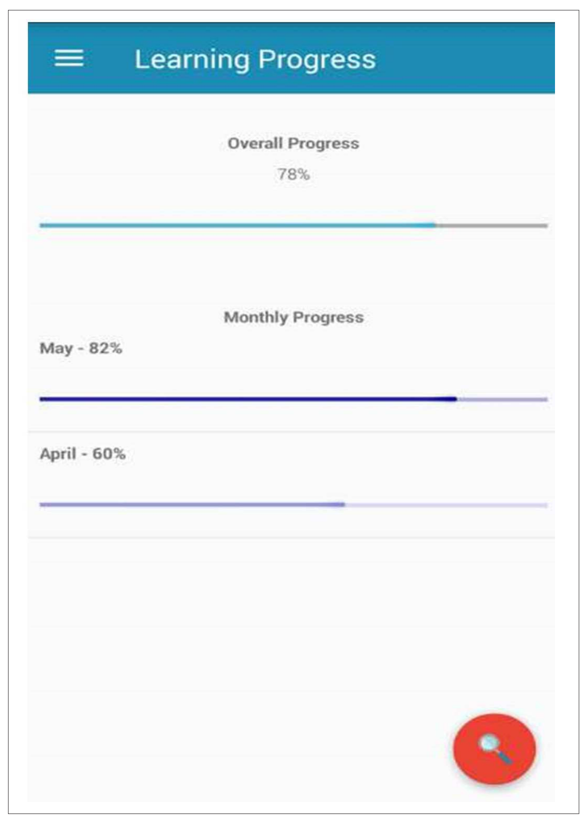

Figure 6. Learning Progress

9. Level of learning: The user will be at level one while navigating their typed query. The user will increase the more profound level by clicking related concepts at the top of the results. At level two, he will be at level three when he clicks associated concepts for the first time. Then, he will be at level four when he clicks related concepts for the same typed question.

Figure 5 shows a screenshot of the session's page for the proposed application.

5.3.3 Learning Progress

The users can track their learning progress while using the application. This progress will be based on the rating sum divided by the number of sessions and user judgment. If the user rates all his sessions with a 5, his learning progress will be 100%. This process will build a relationship between the user and the application. By knowing their searching progress, the user will be encouraged to use the application again. Figure 6 shows a learning progress page.

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To show that page, the following equation has been used:
monthPercentage = (*total* / (*count* * ***MAX_RATE***)) * 100;

The following code shows the *OverallProgress* function:

```
public static float GetOverallProgress()
{UserInfo user = LoadUserInfo();
float overallPercentage = 0;
if (user.Sessions != null)
{
float count = 0;
float total = 0;
for (UserSession session : user.Sessions) {
count++;
total += session.Rating;
}
overallPercentage = (total / (count * MAX_RATE))
* 100;
}
return overallPercentage;
}
```

6. System Evaluation

To evaluate *NaviWeb*, we used three test techniques, namely: Think aloud method testing, user feedback testing, and user-system interaction Testing. The objective was to test *NaviWeb* effectiveness as a learning system and also gather user feedbacks related to aspects such as usability and ease of use.

6.1 Think Aloud Method Testing

This method is usually applied to applications for knowledge acquisition and psychological research. It is classified as an essential method for researchers aiming to build a knowledge-based computer system along with cognitive processes [25], [26]. Since knowledge acquisition is an important aspect to measure in this study, the think-aloud method was applied to two users, as explained in the following two paragraphs.

Think-aloud protocols involve participants thinking aloud as they are performing a set of specified tasks. Participants are required to say whatever comes into their minds as they complete the task. This might include what they are looking at, thinking, doing, and feeling. This process gives observers insight into the participant's cognitive processes (rather than only their final product), to make thought processes as explicit as possible during task performance. In a formal research protocol, all verbalizations are transcribed and then analyzed. In a usability testing context, observers are required to take notes on what participants say and do without attempting to interpret their actions and words, especially noting places where they encounter difficulty. Test sessions are often audio and video-recorded so that developers can go back and refer to what participants did and how they reacted.

The experiment puts users into a relaxing and quiet setting and allows them to use the application without any prior training. The experiment involved ten users from different backgrounds. They were given a brief introduction to the system and asked to search the web for a specific topic and to talk loudly about their impressions, feelings, difficulties, and opinions while using the system. Sessions were not bound by time, the average duration was 5 minutes, and all were recorded. The team categorized users' interactions according to their opinions:

1. Users were captivated by the application; they explored most of the features offered and sometimes challenged the system with unusual queries.

2. They praised that the system provides a blend of information types about the topic searched and a variety of images and videos.

3. The GUI was always compared with Google search engine specifically for information organization, and generally, NaviWeb GUI was commended.

4. The experience of two users was not smooth due to using the application in an Android system.

5. Most users preferred to have videos playing on a bigger screen, but they liked playing inside the application.

6. Some users have noticed that some images are not related to the query topic.

7. Most users found that recalling personal sessions is very interesting, and one user proposed to have the public so that she can use other users' experiences.

Although we did not do this experiment on a large scale, users were generally comfortable using the system. Most of them liked the experience, richness, organization of information, and the history of sessions recorded and retrieved. Also, this experiment was an opportunity for the team to detect the features to improve and others to add to make NaviWeb up to users' expectations. We are considering more specifically to give more screen space to video playing. Making the sessions public is an exciting option that we are considering in the following system release. This option requires users to specify their private sessions, which will be kept within their mobile storage area and public sessions they are willing to share with other users. Public sessions will be stored remotely and shared, commented on, liked, and bookmarked by any user.

6.2 User Feedback Testing

Multimedia information is relevant to my query.

I rate the interaction in the application as ·

I rate the ease of use of the application as ·

I will share the application with a friend

The following chart in Figure 7 shows the results obtained from 20 users:

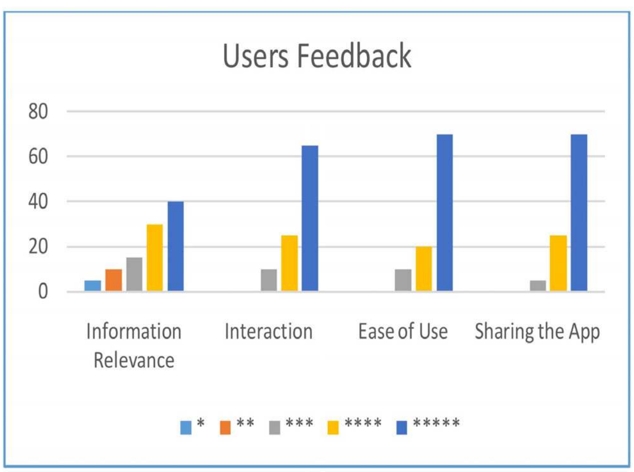

Figure 7. Users' direct feedback

The graph shows that 90% of users are happy (Very Happy or Somewhat Happy) with the interaction experience and the ease of using the application, and 95% are willing to share it with friends. As for information relevance, 70% of users are satisfied with the results retrieved. This fact is predictable somehow as NaviWeb, in this current version, is not accessing the whole web to gather information as classical web search engines do. However, the question about information relevance did-not consider the structure of information organized into levels and other information access facilities such as Related Concepts and Search Sessions. Improvements are necessary to open the system to access all web, multimedia resources and retrieve more relevant information to users' queries. This is one of the main upgrades we are working on for the next NaviWeb release.

6.3 User-System Interaction Evaluation

The effectiveness evaluation objective is to assess NaviWeb as a learning system. In other words, to which extent NaviWeb allows users to learn and get information and acquire knowledge about a topic. This evaluation requirement is not apparent; it simply addresses philosophical questions about human mental processes, how knowledge is represented in the human brain, and how learning occurs, which are beyond the scope of this research. To be more practical, we defined a set of metrics that allow us to evaluate learning effectiveness through a set of visible and measurable criteria that are rooted in the way human learns as it is explained by education specialists and psychologists [28], [29], [30].

To measure the effectiveness of *NaviWeb,* implemented the following metrics in the system, and measures were reported in Table 2. The table shows the results obtained after 100 users have used the system (time is in seconds) .

The results reported in Table 2 represent data collected about initial system users. The system has been deployed on a server, and a link was provided to users asking them to download and install NaviWeb on their mobile phones. No specific instructions were given to users, they were free to use the system and to provide their feedback.

7. Discussion

The system developed in this research aims to leverage users' experiences from simply searching for learning. This is implemented in NaviWeb through system features and an original GUI, which allows searching multi-web sources and managing and organizing elegantly information retrieved. This has been achieved through five elements:

1. Gathering multimedia information, NaviWeb can be seen as a multimedia retrieval system. It collects multimedia information related to the same query from multi-web sources to allow a rich user experience. Displaying multimedia resources for queries was much appreciated by users according to their feedbacks in the think-aloud testing. This original way of retrieving and presenting information creates fruitful interactions and adapts to a broad audience of user profiles.

2. Stimulate learning. To achieve this feature, NaviWeb has been designed to comply with 7 Multimedia Learning Principles [21] to dispense information to incite learning.

Metric	Description	Results
Exposure time	Average time spent in viewing a single learning object.	35 sec
Navigation time	Average time a user navigated the system with a single a query.	97 sec
Navigation depth	Percentage of users who navigated in depth during a session to obtain additional information. This measure takes into account users who requested additional learning objects about some topics by clicking the related concepts.	75%
Navigation breadth	Percentage of users who navigated the same level during a session to obtain additional information.	18%
Learning depth	Percentage of users who reached depth d.	52% (d = 3)15% (d = 5)
History recall	Percentage of users who have used previous sessions by going back to the history.	31%
Query reformulation	Percentage of users who reformulated their initial query to get related information.	5.6%
Rating session score	Average rating of sessions.	4.18 out of 5

Table 2. NaviWeb effectiveness metrics

Table 1 shows how these principles are enforced in the system.

3. Breadth navigation allows users to expand their knowledge about a concept with similar and related concepts. We can access this fact through the “similar concepts” option available in the GUI. According to the evaluation, 18% of users have accessed this feature requesting information about concepts similar to the initial user query. This percentage is relatively small and was against our initial expectations. The possible interpretation of this low score is that sometimes the related concepts retrieved from Datamuse are may be related to the initial concept, but not similar as Datamuse retrieves a set of words matching the user query in a given context. For instance, in Figure 2, the two related concepts of “crater”: “vent” and “mouth” are not very close semantically to “crater” in the context of studying volcanos.

4. Depth navigation is a feature that encourages users to have in-depth knowledge about a concept. It is possible through exploring related concepts at lower levels. Users have widely used this feature to navigate the search results as the evaluation shows that 52% of users have navigated till depth 3. It means that users are keen to investigate and acquire deep knowledge about the concepts they are searching for. This is typical behavior of a learner who requests more knowledge about the concepts he would like to investigate in fine detail. This result demonstrates that users can naturally switch from information seekers to knowledge acquirers when information retrieved is structured. The GUI allows users to sift the content retrieved and hence personalize their learning paths.

5. Search history and session management are valuable features for users to manage their learning progress. Users can get back to their previous sessions and resume their learning from the last LO visited. Table 2 shows that 31% of users have used this feature. This percentage is bound by the time set to collect data for the experiment; it will undoubtedly increase with time as users return to the system and recall their stored sessions. Users in the think-aloud testing praised this feature, and some proposed to share other users’’ sessions.

Sharing others’’ experiences might be an interesting path to pursue in the future, provided that the user’s context matches and privacy issues are handled clearly. Using NaviWeb for web searching is a new experience that triggered users’ interesting reactions, inquiries, and ideas. System interactions showed that users were interested in getting deep knowledge about their initial queries through requesting similar concepts offered by NaviWeb. Also, users were keen to resume their previously saved sessions to continue acquiring knowledge. This authentic experience captivates users’’ interest while searching the web and turned out to have the essential ingredients to stimulate learning.

8. Conclusion and Future Work

This paper presented the development of a mobile system that retrieves and organizes multimedia content elegantly retrieved from the Web. The system provides a learning environment for the user, allowing them to navigate through personalized learning paths to obtain in-depth knowledge. The system uses information from the user's profile and their interaction with the plan to pro duce adaptive learning objects according to the following criteria: the query type, the context, and the level of learning. *NaviWeb* is implemented as a mobile application consisting of four main functions: i) Retrieve information from different sources, ii) Organize the GUI efficiently with the content retrieved from different resources, iii) Display a variety of multimedia information related to the same topic, and iv) Manage sessions, allowing the user to save previous search sessions and results. It is anticipated that this system will facilitate users' learning from their searching experience. Future work will focus on managing users' experiences with the system. Indeed, users' navigation experience represented by the learning path may be re-used to guide other users by offering recommendations for their navigation. Also, we will focus on the user's learning path and analyze it to develop a recommendation learning system. Learning paths will be analyzed to suggest the best learning path for users depending on their profile and system interaction.

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