



UDC 004.2

EDUCATIONAL MOBILE APPLICATION BASED ON CONCEPT MAPS**Fedenko V.A.**

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Abstract. Educational portals proved their efficiency as an integral part of the modern educational process. Due to the new wave of mobile technology, educational mobile applications supplant textbooks and even web-systems. On the other hand the abundance of information leads to an urgent need in knowledge structuring. Concept maps proved themselves as a powerful tool of assimilation and formalization of knowledge. This paper presents a new mobile educational application for distance learning based on interactive concept maps, which will allow learners to explore any subject in an effective way.

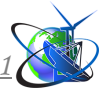
Key words: concept maps, force-directed algorithm, flutter, mobile application

Introduction.

The development of information technology and the widespread usage of the Internet in various fields of professional and scientific activities have made informational and educational web resources an accessible and convenient source of various information of general and professional orientation.

At the same time, the world is unconditionally increasing the use of mobile applications for facilitating access to the necessary information. Today, smartphones have features comparable to the average computer, and this portable mobile device can engage students in the learning process much more dynamically than a laptop or tablet. The benefits of smartphones for students are undeniable due to adding more flexibility and readiness in the learning process.

Information and educational portals should be adapted to the ontology-oriented model of educational content [1]. It provides the formalization of information content, ontological modeling of the subject area and didactic function, which provides presentation and visualization of the required educational information. Usage of concept maps of various types as the method of visualization of professional and educational information has become widespread. This paper is structured as follows: Section “Concept maps in educational processes” highlights the advantages of using concept maps in education. Section “Application development process” details how the educational mobile application is structured. Also, it defines which parts and technologies an app consists of. Section “Result” provides functionality and design of a system. Section “Summary and conclusions” concludes the paper and gives an overview about future works.



Concept maps in educational processes

Concept maps have emerged as a result of research in cognitive psychology. It is an important tool for organizing, presenting and sharing knowledge [2, 3]. First of all, concept maps affect cognitive processes of students and increase the effectiveness of learning because of the visualization of the subject area. Visualization plays a very important role in the acquisition of knowledge. It refers to theories, methods, and technologies by which scientific data is first presented in intuitive graphics or images displayed on a screen, and then interactively processed using computer graphics and image processing technology.

Building a concept map involves creating text nodes that are connected by arcs. A node means a concept, and an arc means a connection between certain nodes. The use of concept maps has proved useful in a number of areas, including primary education and expert knowledge obtaining. On maps, a concept is represented by one node, no matter how many relations it has with other concepts.

One of the advantages of this presentation is that concept maps are usually concise and clear compared to text messages of the same content. Another advantage is that concept maps can decrease cognitive load caused by adding new associations to existing knowledge of a student through the creation of strong cognitive structures in memory. Concept maps allow students to search in a more efficient way and they are more likely to stay in memory for a long time, unlike simple text [3].

Maximum efficiency can be achieved by using concept maps with different shapes and colors of nodes, representing different types of concepts. Indeed, there is evidence that learning is improved by studying maps in which concepts are typified by node spacing, shape, and color [4].

Thus, the use of concept maps in teaching provides a number of advantages: they contribute to a better organization of concepts in a particular subject area, demonstrating the relationship between the main ideas simply and visually attractive.

Application development process

It was decided to develop an educational mobile application, using Dart programming language and Flutter framework, which allows to build cross-platform applications. There were no existing solutions for automatic building of graphs in Dart, so the corresponding algorithm was developed.

1. Application layout prototypes

Figure 1 shows an example of a prototype layout that was created before the development of the application to visualize one of the options for solving the problem of placing a large number of concepts on the screen. In this version, the map of concepts is a graph, the nodes of which are placed on a circle. The user has an ability to rotate the circle with the concepts by swiping up or down. When user clicks on a concept, he sees links to other concepts, which helps him navigate between concepts in an easy way.

Figure 2 shows an example of a prototype layout that formed the basis of the application. This prototype consists of an interface with a subtree of a complete concept map and information panel. The information panel consists of theses related to the active concept and the navigation unit. The user has the opportunity to easily move between concepts and study learning material.

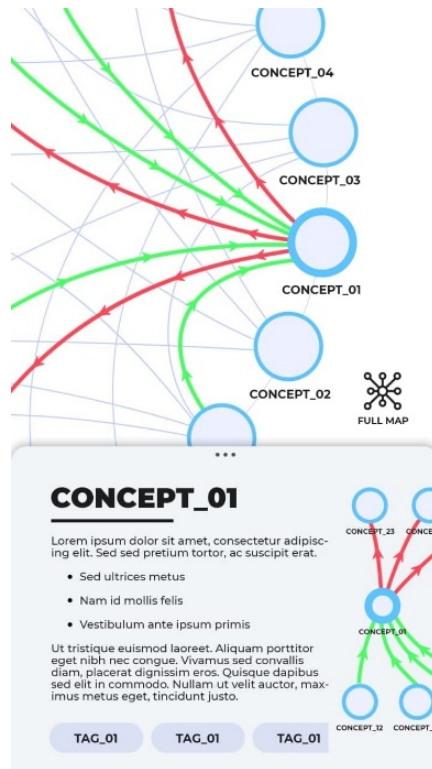


Figure 1 - Prototype layout of circular presentation of concepts

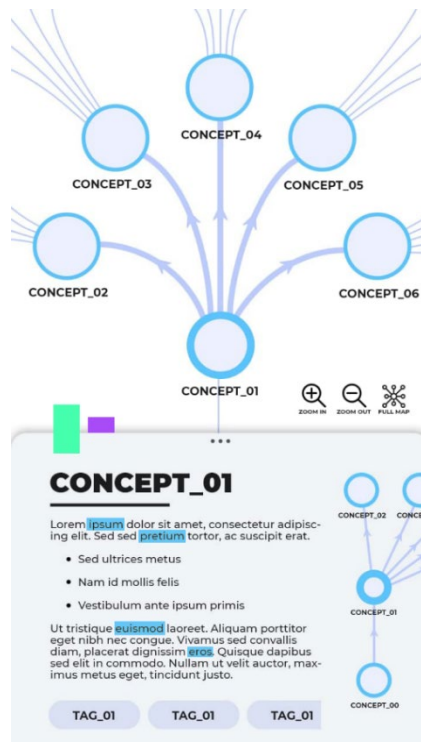
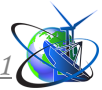


Figure 2 - Prototype layout of tree-like presentation of concepts

2. API structure

All data for building concept maps and courses was taken from the open API of the educational web system Semantic Portal [5]. Semantic-Portal is an educational web portal that uses a concept-thesis model [3, 6] to build concept maps. The site provides the user an access to a list of courses in different areas, for each of which a concept map is built. The API is a set of HTTP requests and some HTTP responses in



JSON format.

3. Force-directed graph drawing algorithm

Fruchtermann-Reingold's algorithm was chosen for visualization of concept maps [7]. The graph visualization obtained during the operation of this algorithm is most consistent with those that were designed before working on the algorithm. The Fruchtermann-Reinhold algorithm uses the forces of gravity f_a and repulsion f_r , which are determined in this way:

$$f_a(i, j) = \frac{d^2}{k}, \quad (1)$$

$$f_r(i, j) = \frac{k^2}{d}, \quad (2)$$

For the force of attraction f_a , k can be written as $a \times \sqrt{(W \times H)/n}$, as $r \times \sqrt{(W \times H)/n}$ for the force of repulsion f_r . Where W – is a frame width, H – is a frame height, n – is the total number of vertices in the graph, a – is the constant for the multiplier of attraction, r – is the constant for the multiplier of repulsion.

This algorithm is a fundamental force-directed algorithm for graph visualization, which helps effectively build visually pleasing graphic structures. This algorithm is very intuitive, because it works on the basis of physical concepts such as the force of elasticity of springs and the force of repulsion of charged objects, it allows understanding how forces can behave and making changes and upgrades to the algorithm in an easier way.

Result

As a result, an educational mobile application based on concept maps was developed. It has a user-friendly interface, relationship analysis function, search and navigation. The application allows users to learn the information they need right from their smartphones, allows them to look at the visual interpretation of the course in the form of a graph and analyze the relationship between its vertices. This approach allows students to understand a subject area better and remember the material in a more effective way.

Figure 3 shows an example of a concept map built in an educational mobile application. The user has the opportunity to choose a concept to study on the map or use the search. The zoom function is provided by corresponding gesture.

Figure 4 shows the information panel that appears when the user selects a concept. The multicolored elements at the top of the information panel are similar to the stickers used in the compendium for quick access to the desired page. These stickers are switches between the information and navigation states of the bottom panel. Figure 4 shows the first state of the information panel, in this state the panel displays the name of the concept and theses related to this concept.

Figure 5 shows an example of the function of analyzing the relationship between concepts. The user can click on the vertice between the concepts, then the bottom



panel displays the theses of the first concept, which includes the second concept and vice versa. These are highlighted by colors corresponding to them on the concept map. This feature allows user to understand the subject area better.

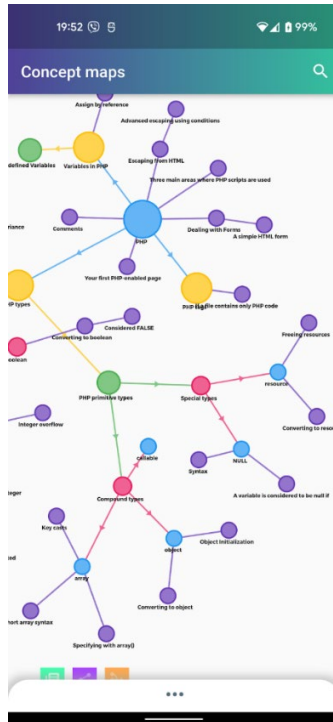


Figure 3 - PHP programming language concept map built in educational mobile application

PHP

- Recursive acronym for PHP: Hypertext Preprocessor

Is a widely-used open source general-purpose scripting language that is especially suited for web development and can be embedded into HTML

The best things in using PHP are that it is extremely simple for a newcomer, but offers many advanced features for a professional programmer

- Is mainly focused on server-side scripting, so you can do anything any other CGI program can do, such as collect form data, generate dynamic page content, or send and receive cookies

Figure 4 - Information panel with theses related to the PHP concept

Figure 6 shows the second navigation state of the information panel. The panel is a circular list of child elements with the parent element in the center. There are always only four child concepts in the user's field of vision, which are schematically displayed in the active concepts display menu, which looks like a list of points. Blue



color shows an active state and gray shows inactive. The navigation list is interactive, the user can rotate it like a roulette wheel. For a more enjoyable user experience, the list has an analogue of physical acceleration, so the speed of movement of the elements in the list depends on the strength of the movement of the finger.

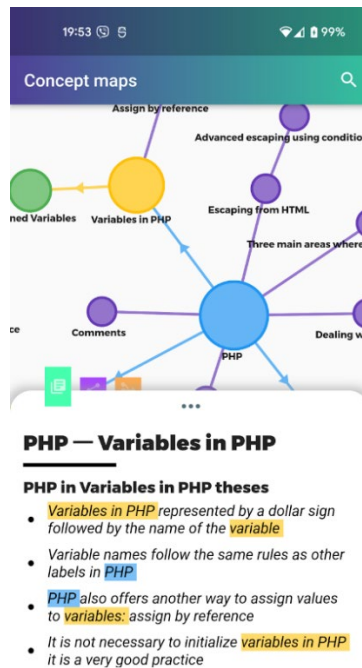


Figure 5 - Information panel with the function of analysis of relations between the PHP and Variables in PHP concepts

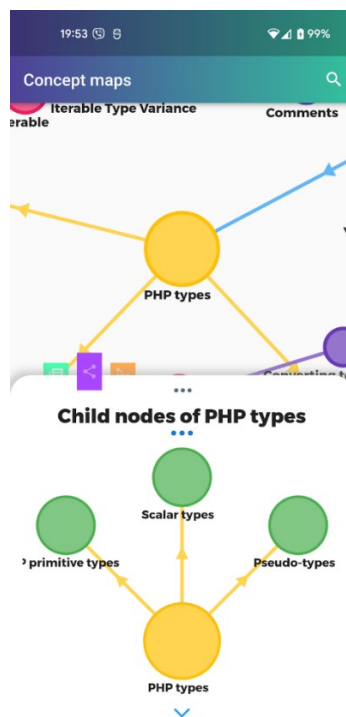


Figure 6 - Navigation status of the information panel of the concept map



Summary and conclusions

Concept maps play an important role in the visualization of knowledge, which leads to better assimilation. This makes them a powerful tool, used in adaptive learning systems. This paper presented a new designed educational mobile application, based on concept maps. This application aims to make learning easier and increase memorization of information. The app has the function of analyzing relationships between concepts to help students understand the subject area in a better way. However, using concept maps in mobile devices has some limitations, such as the difficulty of understanding complex maps with a large number of arcs and nodes. To overcome the problem, the modified force-directed graph drawing algorithm was used. Our future work will be focused on: improving the algorithm for building interactive concept maps; personalizing the application for needs of a specific user, implementing an individual approach.

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