

## Game-based Learning of Bulgarian Iconographical Art on Smart Phone Application

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**Abstract:** The paper presents the newest developments in integrating Bulgarian Iconographical Digital Library (BIDL) and the tourist mobile application family named as GUIDE@HAND for supporting the learning process of East Christian Iconographical Art. Learning content is delivered through the BIDL—a web-based environment for registration, documentation, access and exploration of Bulgarian iconographical artefacts. A new standalone offline mobile application was created providing information on icons available in BIDL where the collection presentation functionality of the former system was enhanced with new features. It provides tools for a game-based learning in selected domains.

**Key words:** Game-based Learning; Bulgarian Iconographical Art; Mobile Application.

### INTRODUCTION

Institute of Mathematics and Informatics at Bulgarian Academy of Sciences (IMI BAS) and Institute for Computer Science and Control at Hungarian Academy of Sciences (MTA SZTAKI) as academic institutions have had an intensive co-operation for many decades. The integration was performed within the framework of a joint IMI-BAS – MTA SZTAKI bilateral academic cooperation project entitled “Development of Software Systems for Multimedia and Language Technologies” (2015-2017).

The Bulgarian Iconographical Digital Library (BIDL) [1], developed by IMI BAS, team is a Web-based environment where iconographical objects of different kinds and origins are documented, classified, and “exhibited” in order to make them widely accessible to both professional researchers and the wide audience. BIDL was integrated with GUIDE@HAND mobile application family developed by the Institute for Computer Science and Control of the Hungarian Academy of Sciences (MTA SZTAKI) in order to make information on Bulgarian icons accessible in off-line mode on mobile devices [2]. GUIDE@HAND is a tourist guide applications family providing tools and interactive services for mobile exploration of cultural places and objects [3][4]. The aim of the applications is to enable visitors to change their perception of new or familiar locations, objects and motives and explore the past and present of an area in an entertaining and exploring way. They are available on iOS (iPhone, iPad) and Android platforms.

Until now IMI BAS – MTA SZTAKI cooperation produces a tourist guide application GUIDE@HAND Veliko Tarnovo including a demo - *guided tour in village of Arbanasi*. It is possible to mark digital iconographical collections with QR codes on the Web page and download and then explore them on mobile devices through the GUIDE@HAND Veliko Tarnovo mobile application. A new standalone mobile application BOOK@HAND BIDL was developed in 2015 and published in order to present the user generated collections of the iconographical library. Now, a new functionality (presented in this paper) is developed for interactive games, supporting the advanced learning on Iconographical Art.

The next section describes BIDL - GUIDE@HAND integrating issues. Section “Interactive games” presents the functionality of interactive games used for ubiquitous learning on Iconographical Art content. The last section contains the conclusions and future work of our development.

### BIDL - GUIDE@HAND INTEGRATION

The Bulgarian Iconographical Digital Library provides services for registration, documentation, access and exploration of a practically unlimited amount of Orthodox iconographical artefacts and knowledge, and end users can use this rich knowledge base through its interactive preview, complex object search, selection, and grouping. The digital

objects could be grouped into thematic collections according to their topics, as results of searching, grouping, etc. For each object and collection, special meta-descriptions are created. They include data about the title, the artist, the period (in years and centuries), the school, the dimensions (width/height/thickness), the technique, the base material (type of wood, ground coat, etc.), the category, the location, the author (biographic data), comments (features of the icon such as state, founder's and other signatures, previous restorations), etc. The system tools are very useful for in teaching in special high-schools for art studies and in self-learning processes, as well [5][6][7][8].

QR codes are a commonly used technique to quickly download content to mobile devices. GUIDE@HAND mobile application family maintains extended QR code services for art exploring. The application used this technique originally to present additional information on objects in museums and exhibitions. The BIDL-GUIDE@HAND integration uses QR codes for marking digital iconographical collections stored in BIDL and for sharing them as virtual exhibitions on mobile devices. The integration opened new ways to present information on icons through the mobile application also in learning process.

During the BIDL-GUIDE@HAND integration, several issues were considered and appropriate services were created. The BIDL content editor tool was improved. This tool allows users to create personalized collections of selected iconographical objects. It helps the users to save, edit, or delete these collections. Furthermore, each collection has a unique QR code, which can be used to generate an export zip file of the selected collection. This export is stored on the BIDL server and can be read by the mobile application.

The mobile application can read this QR code, and if it recognizes that it is from BIDL, downloads the zip file. It stores locally the downloaded collections, manages the collections directory and presents the downloaded icons and the related descriptions (see [2] for more information on the integration).

The integration was originally implemented in GUIDE@HAND Veliko Tarnovo tourist application. MTA SZTAKI and IMI BAS decided to create a new mobile application (BOOK@HAND BIDL) for presenting offline the Bulgarian Iconographical Digital Library (Fig.1). The new application uses the user generated collection presentation capabilities embedded in previously developed GUIDE@HAND Veliko Tarnovo application. It also includes an option to present collections as virtual panorama pictures.

BOOK@HAND BIDL belongs to the GUIDE@HAND application family. Most of these applications (e.g. GUIDE@HAND Veliko Tarnovo) offer functions primarily developed for tourists and other people interested in art and cultural heritage of a destination. These functions are not available in BOOK@HAND BIDL because its target group is restricted to people interested in Bulgarian iconography.

BOOK@HAND BIDL contains the following basic components:

- The *BIDL function* presents general information on the digital library.
- The *Icons function* present some preselected icons.
- The *Download function* can scan QR codes and download collections from the Web page.
  - The *Collection function* presents the downloaded collections.
  - The *Settings function* contains some general setting options of the application (e.g., language, update, etc.) (see [9] for more information on basic components and functions of BOOK@HAND BIDL).

Both the Web page and the smart phone application can be used for learning purposes in the domain of Bulgarian iconography.

The Bulgarian icons can be accessed online by using the **BIDL webportal** through the Web and the pictures of the icons and the related information can be viewed and studied by browsing and searching the digital library.

The **BOOK@HAND BIDL application** can be used as a smart phone based learning environment. The users can plan which icons they are going to visit and download the information about the selected icons in advance. Then the information can be presented on the mobile device without Internet connections. Thus only the icons and information relevant to the given users can be accessed which provides a personalized content to these users and the information about the selected icons can be accessed in a ubiquitous way - anywhere and anytime. The users can view an icon on its site and obtain information (author, iconographical technique, age) about it by using the smart phone in an offline manner. Furthermore, the users can test the acquired knowledge by using interactive games while they are deepening their knowledge, as well. In short, the BOOK@HAND BIDL smart phone application has several advantages over the BIDL portal: it provides information in a ubiquitous, personalized and entertaining manner.

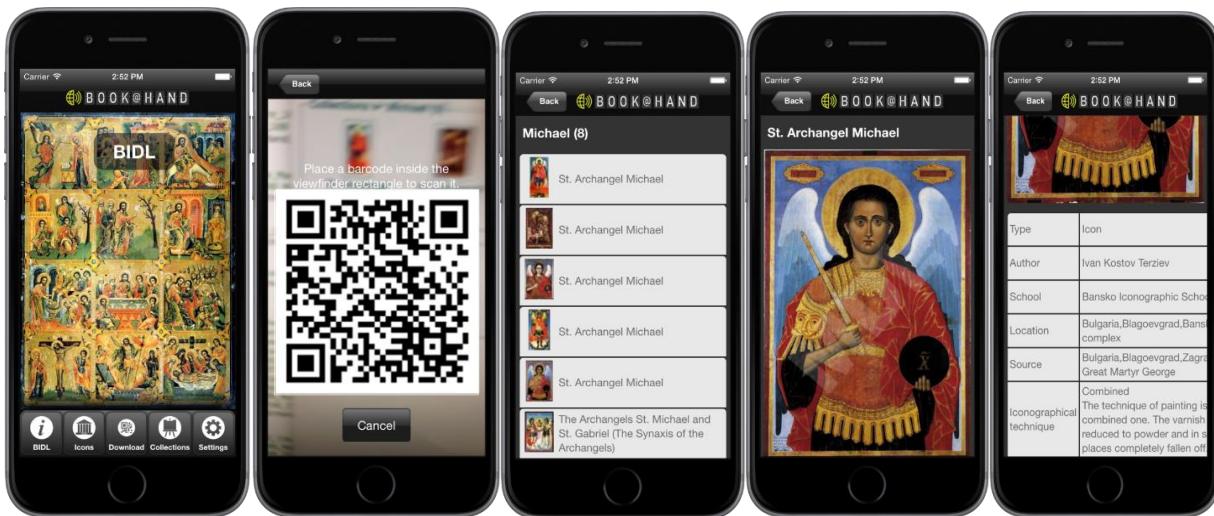


Fig. 1. Observation of an iconographical masterpiece from the Museum of wood-carving and iconography art, Tryavna, Bulgaria by using the BOOK@HAND BIDL platform

## INTERACTIVE GAMES

The BOOK@HAND BIDL application contains several interactive games in order to deepen the users' knowledge related to the Bulgarian icons.

Each game has a question pool that can be maintained by the Game Administrator. During the game, some of the questions are randomly selected from the pool. The application contains the following games:

- Ordering - The names and locations of some icons are given in random order. The objective of the game is to put the icons in chronological order (Fig. 2).
- Blind map - The user should find the source location of the icons on a blind map presenting the provinces of Bulgaria without their names (Fig. 3).
- Memory game - Cards containing the pictures and titles of icons are located along a grid. Initially, the cards are laid face down and two cards are flipped face up over each turn. The objective of the game is to turn over pairs of matching pictures and titles.

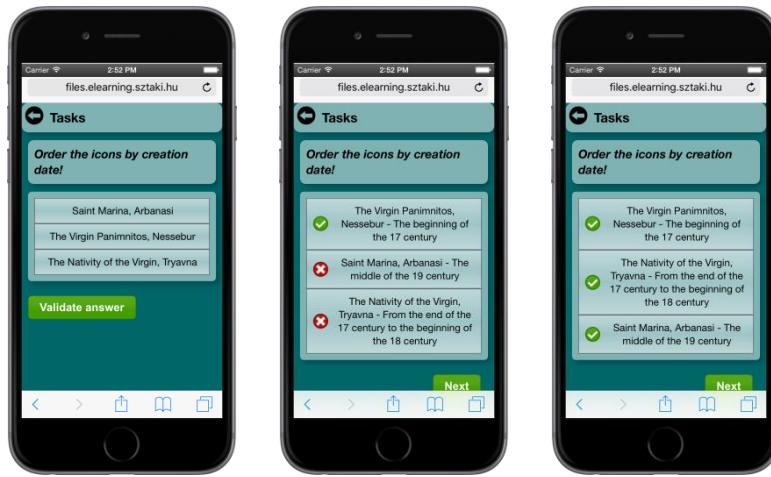


Fig. 2. Ordering game

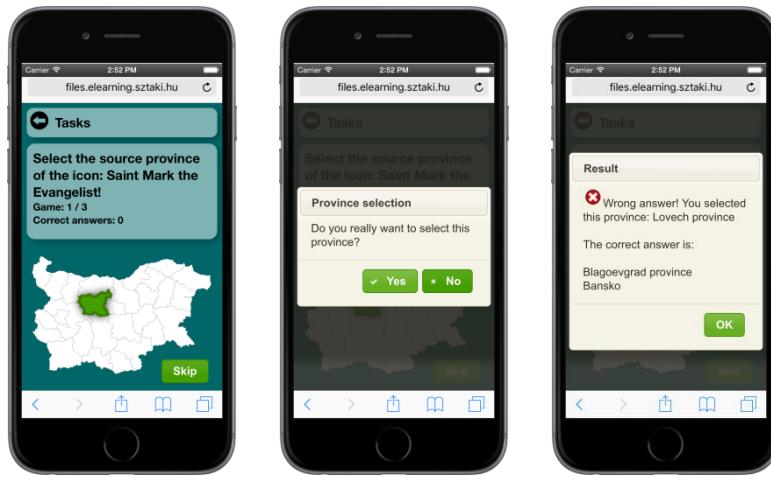


Fig. 3. Blind map

- Sliding puzzle - The pictures of icons are cut into small square tiles. The starting screen of the puzzle contains the tiles arranged in random order with one tile missing. The objective of the puzzle is to move the tiles to their right position thereby restoring the original picture. Tiles can be moved by using the empty space. The puzzle exists in two sizes with different difficulty levels. The easier version has 3x3 tiles, whereas the more difficult version has 4x4 tiles (Fig. 4).



Fig. 4. 3x3 sliding puzzle

The games can run both online on Web and offline on mobile platforms (Android, iOS). Flash had been a popular technology for animations and interactive games. MTA SZTAKI had successfully applied this technology in several projects for Web and Android platforms for many years. However, Flash does not support multiplatform interactive application development because e.g., the iOS devices do not support the application of the technology at all. After the appearance of HTML5, MTA SZTAKI replaced Flash with HTML5 in all eLearning and smart phone developments [10][11]. Based on these development experiences, HTML5 together with CSS3 technology was successfully applied in BOOK@HAND BIDL. Both the iOS and the Android versions represent a stand-alone application. The iOS and Android versions were developed in Objective-C and Java programming languages, respectively.

## **CONCLUSIONS AND FUTURE WORK**

The development introduced above applies mobile devices for game-based learning on Art Study. The application opens new channels to reach and to attract a broader audience with the Iconographical Art content. The future plans are to integrate the interactive games with a Learning Management System or Social Networks. Currently, the icons of the interactive games are independent from the user generated collections. In the next version, the question pools of the interactive games will be based on the icons of the downloaded collections. Our experiences gained in mobile application development could also be successfully exploited in relation to other collections, and we are looking for further contents.

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