# Smart m-Observation and Study of Orthodox Art

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**Abstract.** This paper presents a progressive web application for Bulgarian iconographical art that provides specific and complex features for knowledge discovery, dynamic categorization, filtering, content analysis, shared content usage, *etc.* The main goal of the application is to make the learning process of students interactive and full-fledged through m-observation and to provide an easier and more effective way of researching and comparing iconographic objects.

**Keywords:** Mobile Learning · Progressive Web Application · Orthodox Art

## 1 Introduction

Orthodox art represents an era with great effect on spiritual life and strive for culture. So it is of utmost importance that it is accessible digitally for the purpose of education, culture and observation. Studying and understanding Orthodox artworks is not easy and requires different tools and methods, especially when they will be used for e- or m-learning. Orthodox art resources, metadata, how they can be accessed, searched and selected and displayed in a content management platform are extremely important for an innovative and ubiquitous learning process.

The development of digital technologies is changing the way students learn and teachers present learning material. Contemporary education in the humanities and social sciences is increasingly supported by specialized digital libraries, virtual museums, virtual reconstructions of historical sites, *etc.*, accessible via either desktop or mobile devices. Recent studies show that most students are positive about such a change and mostly use mobile technologies, despite some hardware or software limitations or the inability of the students themselves to use such devices properly [1, 2]. For example, small screen size and quality present challenges for user interface visualization, categorization and presentation of materials, which is especially important when comparing virtual historical objects such as relics or paintings from different periods. In order to enable deeper exploration of historical content, specialized functions like search options, content categorization and filtering have to be easily accessible to students. On the other side, the ability to easily access any content and communicate with anyone regardless of their


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location and physical abilities is something that facilitates collaboration and learning [3, 4]. Mobile technologies increase the engagement of students and their feeling of belonging to a group [5]. Mobile technologies provide flexibility at a low cost and learning across platforms, devices and locations [6]. In combination with virtual reality (VR) and augmented reality (AR) solutions, m-learning may help students to better acquire historical knowledge. Using VR solutions, they can virtually walk through museum exhibitions or visit historical ancient places [7]. Also, by using AR students can access multimedia storytelling about monuments near them or see a 3D reconstruction of the parts that are missing in real-time at the exact location.

The purpose of this paper is to present a progressive web application (PWA) for Bulgarian iconographical art, targeting improved learner m-experiences and providing specific and complex features for knowledge discovery, dynamic categorization, filtering, content analysis, shared content usage, *etc*. Effective art study requires the students to be engaged actively in the observation and analysis phase in more interactive and meaningful ways so the main goal is to identify and provide technological solutions for smart mobile observation and study of Orthodox Art. In Sect. 2 we focus on the used methodology and technology and in Sect. 3 we discuss the achieved results – the software platform, its functionality, current usage scenarios, impact and testing. The conclusion summarizes the achieved results.

## 2 Approach

### 2.1 Used Methodology

The development of the application follows the research and development method - starting with the stages of identifying m-learning context, data collection, and software and hardware analysis. Problem identification is carried out by using observations and interviews with target groups (lecturers and students at art schools and universities) for using mobile applications in the education process as a whole or for specific learning scenarios. For the software analysis stage, the used dataset is based on the Digital Library "Virtual Encyclopedia of Bulgarian Iconography" (BIDL, https://bidl.math.bas.bg/en), which current version is developed as an infrastructure component of the Bulgarian National Interdisciplinary Research e-Infrastructure for Resources and Technologies in Favor of the Bulgarian Language and Cultural Heritage. That stage identifies how the target dataset and services can be customized in the mobile version for the needs of education and to accomplish improved learner m-experiences of art students. In the hardware analysis phase, different types of mobile devices are tested to see how they can be used for specific educational goals.

In the next stages, we go through product design and development, software testing and validation, and product evaluation and revision. The product design and development stages include creating detailed specifications of all the required features and services and their realization. The last stages are software testing and validation, product evaluation and revision with users to get to the final stable product.

### 2.2 Used Technologies

The BIDL platform is based on some of the most powerful technologies used for web development - a load-balanced Node JS-based back-end server behind NGINX web server, No-SQL database management system - MongoDB, Vue and Bootstrap as front-end frameworks and SPHINX search for the full-text index search capabilities. The platform is implemented using a three-layered architecture (database, application, and presentation layers). Each layer is divided into two parts – core and custom. This allows the platform to be widely reused for different purposes. Following the currently developed technological web-based infrastructure, a transformation into a progressive web application is a reasonable continuation of our strategy to create a closer relationship between technologies and users.

Progressive web applications as a technology enhance the described infrastructure, providing many features common for modern native mobile applications [8]. PWA is not only a web application, it is a new philosophy for building such. It defines some specific patterns and good practices, application interfaces (APIs), and other features. The most significant features that a PWA has in comparison to a traditional web application are the ability to use the device's storage, periphery (USB devices attached), camera, and geolocation. PWA can send push notifications and they are installable and updatable just like a native mobile application. PWA is cross-platform. This means the same codebase can be used on Android, iOS, Windows, Linux, *etc*.

## 3 Actual Outcomes

### 3.1 BIDL m-Application

The main objective of BIDL platform is to store and manage different types of digitized copies of Orthodox artworks, including text, graphics, video, or other media objects as well as the relevant metadata, based on ontology [9]. The Orthodox iconographic objects presented originate from the end of the XII to the beginning of the XX centuries and the majority of them belong to significant Bulgarian schools of iconography such as iconographic schools in Bansko, Tryavna, Samokov, Strandzha, as well as icons from Veliko Tarnovo, Rila Monastery, Arbanasi, *etc*. churches, monasteries, and private collections. The objects are grouped into thematic collections according to different descriptive criteria (classes in the descriptive ontology), incl. Title, artist, period (in years and centuries), school, iconographic technique, base material, location, *etc*. The application offers dynamically extensible schemas for the meta-description of the target dataset allowing dynamic updates of the metadata for sustainable enrichment. These features and those offered for full data access, enhanced searching, dynamic content categorization, filtering, and customized grouping make the platform a versatile learning tool used in art schools and universities during their laboratory and outdoor learning activities. Figure 1 depicts a thematic grouping of iconographic objects by schools and resulting content.

In addition, the PWA infrastructure allows the implementation of a proactive m-observation environment, giving the users the ability to be notified when new content related to their interests is available, or when other user-related events are triggered. The

access of PWA to the user device's camera, geolocation, and push notifications gives us the ability to implement specific features for on-place analysis and learning. The PWA is able to identify the user's location, match it with relevant content from the BIDL metadata database (icons relative geolocation), and send push notifications to the user if specific content is found. The camera can be used for identifying specific image content and finding matches in the BIDL content database.

Augmented reality technology is used in the created application to recognize the icons in visitors' surrounding and to provide information about them. When the camera of the mobile device is directed towards an icon, AR software compares the image captured by the camera with previously prepared images of icons stored in the application database. When the icon is recognized, a virtual button for more information about the icon is displayed as an overlay. The button overlay is positioned in real time and tracks the icon in 3D space while the icon is in the field of view of the mobile device camera. The interaction with the button enables the loading of educational content from a purposely prepared m-learning platform.

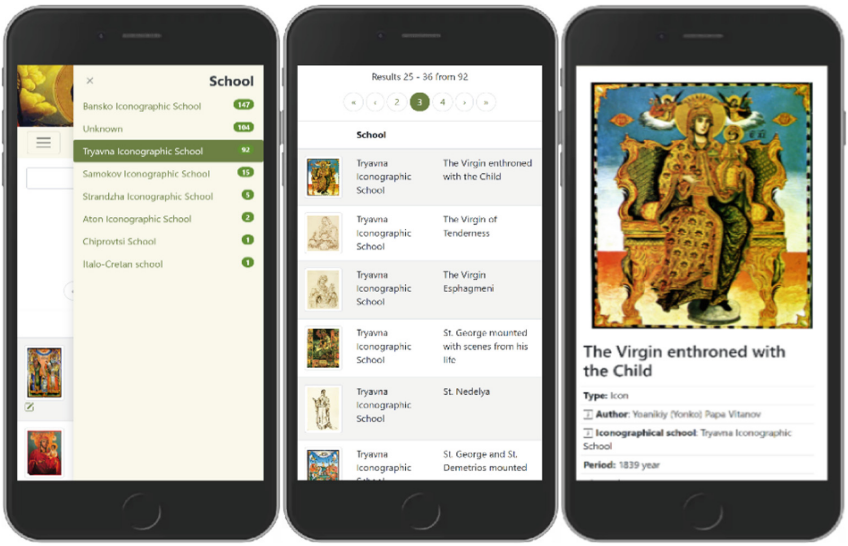


**Fig. 1.** Thematic grouping of iconographic objects by schools and resulting content.

### 3.2 Educational Usage and Impact

The realization of the application is forced due to a shift to online education of students. The m-observation and study were done with specific churches, monasteries, museums, regions, iconographic schools, *etc*. The functionality of the mobile application allowed one to carry out tasks and projects related to art critic analysis of the chronological development of iconography. Moreover, comparing iconographic objects in one or more iconographic techniques and evaluating the quality of their execution; periodization of

basic iconographic techniques were used in the best Bulgarian examples of iconography; comparing selected iconographic objects in terms of clothing, gesture, proportions of characters and objects, presence of another character or symbol, backgrounds, other elements in the iconography of the image, *etc*. The ability to share results provides conditions for completing tasks in a group. At the same time, even during an individual visit to a certain church or museum, the m-observation makes it possible to use the database for additional and more detailed information about the observed and studied objects of Orthodox art, as well as to use already achieved results on assigned tasks and projects.

The application was provided to art students that study iconography to see whether the developed functionality is useful for their work. During the testing period the students shared that most of them (more than 80%) were satisfied with the features of the application. They were able to make observations on different iconographic objects without the need of being present in the specific place or if present it increased their productivity when they needed to observe a specific object and compared it to other objects of the same period, technique, base material or other features. They also pointed out that having all of the information for example for a specific period and object in the palm of their hand sped up their research and learning process. They discovered that even if seeing the object in person, they could observe the object in more details (zoom in through the application) and compare it with the actual display and read up about it in the application and to find some other research papers on the topic.

The application would be helpful not just for art students that are learning about the domain, but for visitors of churches, monasteries, museums, *etc*. Providing an easy way of observing and comparing objects makes the experience of visiting memory institutions more fulfilling. The specific and complex features for knowledge discovery, dynamic categorization, filtering and content analysis can provide a fulfilling experience to any visitor - from the art student that needs to research the objects to the ordinary visitor that would like to just learn more about the domain. We should however admit that young people would be more inclined to use this application as they are more comfortable with mobiles and mobile applications.

## 4 Conclusions

In this paper the symbiosis between mobile application and Orthodox art and culture has been studied. The digital representation allows a rich educational process in a live environment with access to everything at any moment. With this application it is possible to learn with more focus on the practical side - such as observing, analysing and studying target artefacts and iconographic content (iconographic schools, authors, art periods, *etc*.); finding or verifying features and influences; making new art or learning projects, documentaries, performance, exhibitions, interactive virtual gaming and gamification, storytelling, studying, *etc*. The content-dependent use of digital objects for different learning purposes is applicable in real life and stimulates creative thinking, learning-by-doing and learning-by-authoring, the force of any successful and lasting learning.

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