Pedagogical Valences of the MIT App Inventor® Platform in Creating Applications for Soil Monitoring and Protection

PhD Eng. IT expert **Bogdan-Vasile CIORUȚA**[1,3,*], Stud. **Ioana-Elisabeta SABOU (CIORUȚA)**[2], Assoc. Prof. Dr. Eng. **Mirela-Ana COMAN**[3,4], Eng. IT expert **Alexandru Leonard POP**[1]

[1] Technical University of Cluj-Napoca - North University Centre of Baia Mare, Office of Informatics, 62A Victor Babeș Str., 430083, Baia Mare, Romania

[2] Technical University of Cluj-Napoca - North University Centre of Baia Mare, Faculty of Letters, Department of Specialty with Psychopedagogical Profile, 76 Victoriei Str., 430083, Baia Mare, Romania

[3] University of Agricultural Sciences and Veterinary Medicine from Cluj-Napoca, 3-5 Calea Mănăștur, 4000372, Cluj-Napoca, Romania

[4] Technical University of Cluj-Napoca - North University Centre of Baia Mare, Faculty of Engineering, 62A Victor Babeș Str., 430083, Baia Mare, Romania

* bogdan.cioruta@staff.utcluj.ro

Abstract: *In today's information consumption society, key competencies are considered to represent a multifunctional, transferable package of knowledge, skills, and attitudes, which all individuals need for personal fulfillment and development, social inclusion, and finding a job. In addition, they must have developed by the end of the compulsory education cycle, to act as a foundation for lifelong learning. In this context, through the present work, we aimed to identify, analyze, and describe the pedagogical valences of the MIT App Inventor® platform in the configuration, creation, and development of dedicated applications, especially for the monitoring and protection of soil resources.*

Keywords: *MIT App Inventor®, applied pedagogy, soil protection, dedicated mobile applications*

1. Introduction

Modern trends in the social and professional development of individuals are defined not only by the information society but increasingly by a knowledge-based society (Society 5.0), which is affected by the rapid changes in the digital world 0 and which focuses on human productivity in advanced technological services 0. To understand their content and their implementation strategy, it is necessary to fully understand the increasingly visible contradictions, with the current society of information consumption 0.

The current society of information consumption requires the rigorous selection of materials and documentation tools, from the immense amount of academic information generated in the last decades 0, in which case the skills of searching, sorting, and filtering information are more than a necessity. Moreover, in the same context, it is considered that digital literacy and the associated key competencies represent a multifunctional, transferable package of knowledge, skills, and attitudes that all individuals need for personal fulfillment, social inclusion, and finding a job 0. These skills must have been developed by the end of the compulsory education cycle and must act as a foundation for lifelong learning.

Moreover, to facilitate the acquisition of such key skills, in the process of selecting digital tools, teachers are the ones who must follow the pedagogical valences of the platforms (e.g., *the degree of interaction*, *communication, and collaboration*; *the implications for the development of skills specific to the 21st century*; *malleability and adaptability to various multidisciplinary work scenarios,* etc). To achieve this main task, methods of analysis and synthesis, prediction, comparison, and abstraction are usually used 0. A rigorous selection of work tools brings the most diverse benefits, namely a much more comfortable learning environment, where the exchange of best practices and assistance can be much more accessible.

Educational applications, tools, or platforms are an excellent way to complement traditional classroom learning, providing both resources and digital content for pupils and students, as well as virtual spaces for carrying out the most diverse educational activities.

These applications, tools, and platforms often include features such as interactive content, quizzes and games, virtual tutoring (e.g. personalized learning paths), and combinations thereof, which can provide/reveal valuable information about both learner preferences, motivation, and engagement, as well as about their adaptation and resistance to the new 0.
All of the above can be used to help pupils and students learn, develop skills, and build attitudes - from math and science (eg, concerning STEM) to the arts and social sciences. In addition, many of these applications, tools, and platforms include reporting and (benchmark) analysis functions, which allow teachers to monitor student/student progress and measure the effectiveness of educational interventions. In addition, they must allow for association with the highlighted knowledge, skills, and attitudes, which in turn must have been developed by the end of the compulsory education cycle, acting as a foundation for lifelong learning. In this context, through the present work, we aimed to identify, analyze, and describe the pedagogical valences of the MIT App Inventor® platform in the configuration, creation, and development of dedicated applications, especially for the monitoring and protection of soil resources.

2. Material and methods

About the use of current mobile devices (e.g., phones, laptops, tablets, smartwatches, etc.) we note the existence of a special information link with the environment. Also, users of these categories of devices have access to an almost infinite offer of multimedia educational content; in this sense, we refer to databases and information obtained through sensors and/or associated applications. Regarding the establishment of the framework for configuration, design, and creation of mobile applications dedicated to soil protection, as a working method, we tried several scenarios, namely innovative puzzle-type programming environments (**Fig. 1**), which are based on the drag-and-drop programming technique (e.g., *Android Studio*®, *apprat.io*®, *AppsGeyser*®, *AppyBuilder*®, *Basic4Android*®, *Kodular*®, *MIT App Inventor*®, *Thunkable*® etc).

Fig. 1. Configuration, design, and development environments used to create mobile applications

After comparing the facilities offered and the ease of application implementation, we opted for the version provided by the MIT App Inventor® platform, under development at Google®, designed and used as a teaching-learning tool in a variety of real contexts.
A substantial contribution to the choice made was also the use of the platform in question (i.e. MIT App Inventor®), successfully "in learning programs, summer schools, workshops for teachers, and in programs dedicated to the faculty" 0. Thus, over the years, there have been several attempts to simplify the software development process and allow users to learn to develop their mobile applications through MIT App Inventor® 0-0. As such, to date, 6.8 million people in more than 190 countries have used MIT App Inventor® to create more than 24 million apps to provide solutions to real problems in their communities.
In the context of the above, we will try from a pedagogical perspective to identify, analyze, and describe the pedagogical valences of MIT App Inventor® in the configuration, creation, and development of dedicated applications, especially for the monitoring and protection of soil resources, by referring to other specialist articles and relevant user reports/observations.

3. Results and discussion. Using the MIT App Inventor® platform as a pedagogical tool

3.1 Functional features and characteristics

Over the years, as I was able to notice by leisurely consulting the specialized literature, there have been several attempts to simplify the software development process and allow everyone interested to develop their applications through the MIT App Inventor® platform, respectively HAMILTON, 2011; JORDAN and GREYLING, 2011; TYLER, 2011; WOLBER, 2011; WOLBER et al., 2011; ABELSON et al., 2012; GRAY et al., 2012; KRISHNENDU, 2012; MACKLLAR, 2012; POKRESS and DOMINGUEZ, 2012; POKRESS et al., 2012; MITCHELL, 2014-2016; PARTDIKURI, 2014; ZHANG, 2014; TURBAK et al., 2014; AMERKASHI, 2015; KRISHNENDU, 2015; SHERMAN, 2015; WALTER and SHERMAN, 2015; WOLBER et al., 2015; COLTER, 2016; TSAI, 2016; XIE and ABELSON, 2016; GERBELLI and GERBELLI, 2017; GUTHALS, 2017; VOŠTINÁR, 2017; XINOGALOS et al., 2017; XINYUE, 2017; MARTINEZ and MARTÍNEZ-IJAJÍ, 2018; PANSELINAS et al., 2018; TANG, 2018; CHO, 2019; CLARKE, 2019; PATTON et al., 2019; RUIZ-RUBE et al., 2019; TSVENTOZAR, 2019; LOGAN, 2020; yes CRUZ et al., 2022; LANG, 2022; CIORUȚA et al., 2022 etc. (Fig. 2).

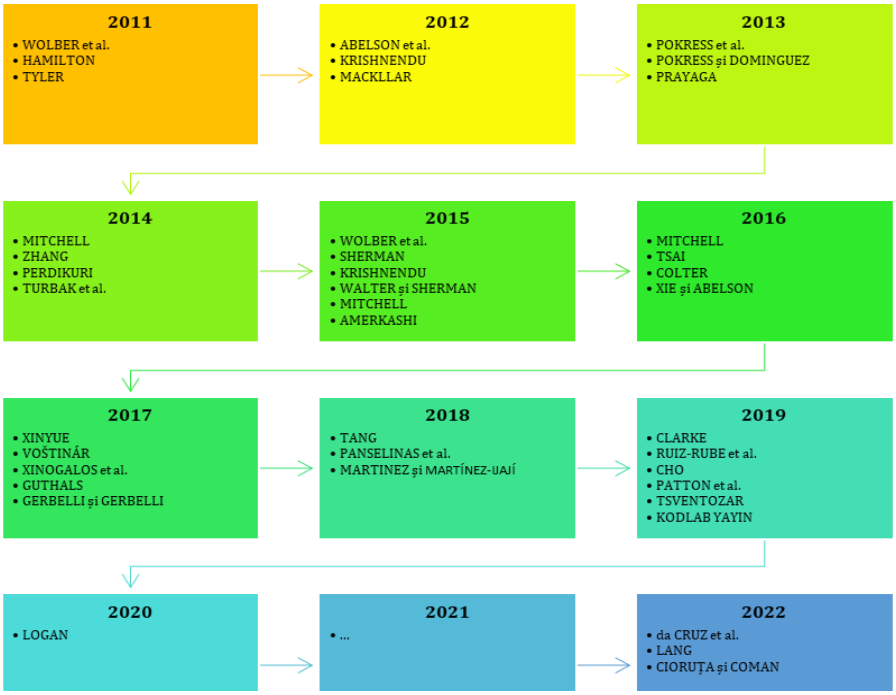

Fig. 2. An insight into the authors who researched the MIT App Inventor® app closely

MIT App Inventor® is a tool that can bring software development to the masses, rather than being in the hands of a small number of professionals 0. It has been defined in the specialized consulted literature as:

- "(...) a new drag-and-drop visual programming tool for building mobile applications on the Android platform" 0;
- "(...) an informal online learning environment with over 5 million users and 15.9 million projects/apps created" and "an environment that uses a visual language based on blocks to enable people to create mobile applications for Android devices" 0;
- "(...) an open-source programming tool based on blocks that allow users with no previous programming experience to create apps specifically for mobile devices" 0.

For the above, we define the App Inventor® tool as "a new drag-and-drop visual programming environment or an informal web-based platform that allows users - non-programmers or beginners - to create applications for mobile devices". It follows step by step, several milestones highlighted by computer-assisted instruction, and presents attributes that are worth pursuing from the perspective of applied pedagogy and educational alternatives.

2.2 Pedagogical implications and valences in creating new mobile applications

In direct relation to the current state of knowledge regarding the configuration, creation, testing, and use of mobile applications dedicated to soil protection, it is certified that the use of modern technologies represents a very topical challenge for specialists in many fields of activity, implicitly for those who are in charge of monitoring environmental factors, economic evaluation of ecosystem services, ecological security, soil protection, etc.
In the same context, alignment with international standards specific to soil protection requires the use of GIS/GIS, monitoring of specific quality parameters, data processing with specialized programs, creation of mega-databases that can be updated in real-time, etc. Moreover, nowadays, mobile applications dedicated to soil protection occupy a well-defined place in all fields of activity: production and service provision, management and monitoring, research, and public involvement in decision-making. These have become mandatory and necessary tools in soil science, which track specific and relevant indicators for soil protection.
Among the modern technologies that ensure alignment with the above standards, MIT App Inventor®, as a configuration and development environment for various categories of mobile applications, accesses device functions (e.g., *camera for capturing images and sound recording*, *GPS module for logging location, altitude, and orientation*, etc.), stimulates creativity, encourages innovation, (re)defines application design, but also develops and supports research skills. It enables users to create and share fully functional Android applications, providing an innovative way to solve increasingly complex environmental problems.
The creation of various mobile applications is done with the *MIT App Inventor® Designer* - where the graphic components for the desired application are selected and the block editor (*MIT App Inventor® Blocks Editor*) - where the code blocks are assembled like pieces of a puzzle, and where you specify how the tools used in creating the interface should behave.

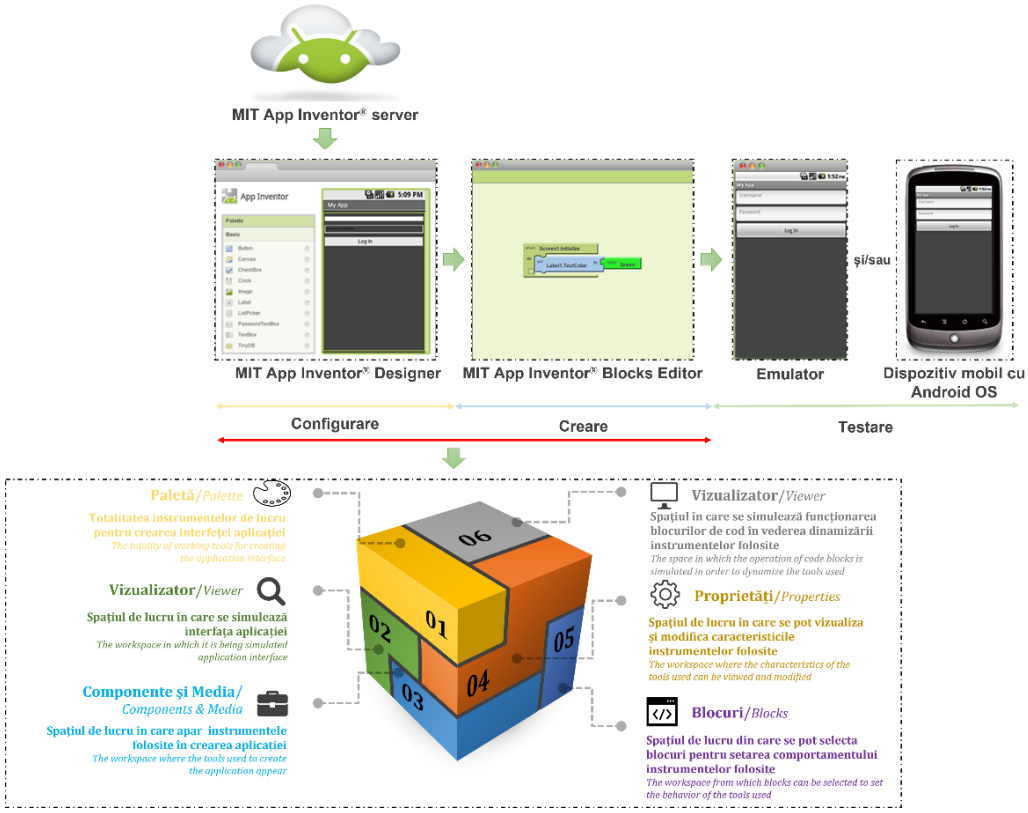

Fig. 3. How to configure, build, and test a mobile app in MIT App Inventor®

The application appears on the phone, step by step so that the work done can be tested while the construction continues. Users who do not own a device with an Android operating system can create the applications using the *Android emulator* (software that runs on the computer screen, behaving similarly to a mobile device).

From the interaction of the users with the application menu and with the functionalities it proposes (Fig. 4), various aspects can be determined, such as *the degree of structuring and organization of the educational material*, *the degree of interaction*, *the degree of communication and collaboration*, *the implications in the development of the 21st-century specific-skills* (e.g., digital skills, language skills, entrepreneurial and innovation skills), *malleability and adaptability to various multidisciplinary work scenarios*, etc. All these characteristics were recorded in Table 1, where, along with the App Inventor® platform, other development environments with similar characteristics were considered, tested, and analyzed.

	App Inventor	DroidDraw	Rhomobile	PhoneGap	Appcelerator
			Mobile Platform Compatibility		
Android	Yes	Yes	Yes	Yes	Yes
iPhone/iPad	No	No	Yes	Yes	Yes
Windows Mobile 6	No	No	Yes	Maybe	No
Windows Phone 7	No	No	Maybe	Maybe	No
Palm	No	No	No	Yes	No
BlackBerry (RIM)	No	No	Yes	Yes	Planned
Symbian	No	No	Yes	Yes	No
			Development Environment OS Support		
Windows	Yes	Yes	Yes (no iPhone)	Yes (no iPhone)	Yes (no iPhone)
Mac	Yes	Yes	Yes	Yes	Yes
Linux	Yes	Yes	Yes (no iPhone)	Yes (no iPhone)	Yes (no iPhone)

Fig. 4. Interaction of mobile application development environments with device operating systems

Table 1: Characterization of mobile app development environments with their pedagogical values

Pedagogical aspect followed / Platform	The degree of structuring and organization of the material	The degree of interaction	The degree of communication and collaboration	Implications in the development of digital skills	Adaptability to multidisciplinary work scenarios
Appcelerator®	++	++	++	++	++
Android Studio®	+++	++	+++	**++++**	**++++**
apprat.io®	++	+	++	++	++
AppsGeyser®	++	+	++	++	++
AppyBuilder®	++	+	++	++	++
Basic4Android®	++	++	+++	+++	++
DroidDraw®	++	++	++	++	+++
Kodular®	**++++**	**+++**	**++++**	++	+++
MIT App Inventor®	**++++**	**+++**	+++	**+++++**	**++++**
PhoneGap®	++	+	+	++	++
Rhomobile®	++	+	++	++	++
Thunkable®	**++++**	**+++**	**++++**	++	+++

From the analysis of the results obtained, as a result of the interactions with the students, favorable characteristics of using the App Inventor® application for various teaching-learning-evaluation scenarios are noted. The degree of structuring and organization of the work material, practically the menu of functionalities itself, includes several components that familiarize the user with IT concepts, while also allowing knowledge by association of the Kodular® and/or Thunkable® platform. The degree of interaction and the degree of communication and collaboration are also on the same principles as in the case of the two previously mentioned platforms.
Regarding the implications of the MIT App Inventor® platform in the development of digital skills, as well as its adaptability to support various multidisciplinary work scenarios, these elements can only be appreciated and validated by direct reference to the creation of mobile applications for various

fields of interest, from themed games and applications for courier services to applications for the monitoring and protection of soil resources.
For the latter scenario, the MIT App Inventor® platform provides a unique and impressive palette of elements for designing and automating mobile device components (e.g., *interface configuration elements*, *graphics, and animation elements*, *elements for data science and processing*, *elements for sensor management and data storage* etc), in which case it leads detachedly about the last two characteristics considered.

4. Conclusions

Ensuring access to the key skills needed by today's society, including digital ones, should find its natural place in teaching-learning-assessment approaches, and be equally within the reach of each learner. Responsible for this initiative is the teaching staff who should manage the training climate (by finding the right work options, as well as the favorable tools for the efficient performance of the tasks).
In the sense of the mentioned, teachers must be able to characterize the applications used, including the application development environments, in full agreement with the current needs of the students they train. The pedagogical values of the applications, referring to *the degree of structuring and organization of the educational material*, *the degree of interaction*, *the degree of communication and collaboration*, *the implications in the digital skills development*, *the malleability and adaptability to various multidisciplinary work scenarios,* etc, teachers must ensure that it offers a multifunctional and representative package of knowledge, skills, and attitudes that all individuals need for personal fulfillment, social inclusion and finding a job.
In the case of the MIT App Inventor® platform, which has validated and recognized affinities in the configuration, creation, and development of dedicated applications, especially for the monitoring and protection of soil resources, the specific pedagogical valences of digital systems used in training appear, the evaluated characteristics having values far above of other similar applications. This result does nothing but certify that the MIT App Inventor® application has pedagogical valences with various classroom work scenarios and that, equally, it can be a useful teaching tool in supporting the configuration, creation, testing, and use of mobile applications in various fields.

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