



# **Soil Protection and Mobile Apps Created with App Inventor<sup>®</sup> - A Multidisciplinary Symbiosis?**

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## **Authors' contributions**

*This work was carried out in collaboration between both authors. Author BVC designed the study, performed the statistical analysis, and wrote the first draft of the manuscript. Author MC managed the analyses of the study. Both authors read and approved the final manuscript.*

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## **ABSTRACT**

This paper aims to highlight the My Soil Protection App's adaptability and compatibility with the demands of the current digital consumer society by starting with a definition, descriptive characterization, and synthetic analysis of the MIT App Inventor<sup>®</sup> platform (following users' perceptions over the previous 10-12 years). In this sense, concurrent with the examination of how

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the platform may be utilized in soil protection plans and strategies, the establishment and creation of a digital field agenda (My Soil Protection App) are carried out. My Soil Protection App, an application we developed, requires the MIT App Inventor<sup>®</sup> platform functionalities to be coupled with data specifically related to soil resource protection (local environmental characteristics, climate variables, land usage typology, etc). In the Office of Informatics, between October 2020 and December 2021, we conducted an assessment that included identifying and grading the platform's components that would be used to create specialist soil protection apps. The analytical technique covered the fundamental components of mobile devices (including sensors) that might be used in the collection and management of field data. As a result, it was discovered (through implementation, testing and validation of functionalities) during the application's development that modern soil preservation procedures may make good use of the App Inventor<sup>®</sup>. We suggest using MIT App Inventor<sup>®</sup> (via the user interface, media, and sensor components) if you feel the urge to create an application because it promises a computer-soil science stronger fusion.

*Keywords: Sustainable agriculture; soil protection; MIT App Inventor<sup>®</sup>; mobile apps setup.*

## 1. INTRODUCTION

Since the Stockholm Conference (1972), which established the United Nations Environment Program (UNEP) and was held at the same time the term "environment" was added to the international agenda [1], it has become increasingly clear that the gathering and analysis of environmental data are crucial for humanity [2,3]. Due to the benefits provided by new information and communication technologies, terms like "information society", "communication society", and "information consumption society" have been mandated to designate a single existential reality [4], a reality in which information access and the development of an information culture are dominant [5,6].

The ability to find, evaluate, and effectively use information resources is crucial for many businesses and people with political, social, economic, or environmental protection duties in today's society, which is characterized by the new reality [4,5]. Furthermore, the efficiency to which we refer is directly related to the accomplishment of the suggested informational, documentary, or knowledgeable purposes, as well as to the existence of concrete circumstances for making specific decisions, optimizing particular procedures, or using particular methodologies in preference to others [6,7].

No matter what branch of science and technology we examine, it is clear that the amount of information we are working with is unmatched in human history. Environmental sciences are no exception; without the assistance of contemporary information technology, specifically Environmental

Information Systems (EISs) [8,9] or, why not, Environmental Informatics (EI) [10–12], recent advancements in this field would have been unthinkable, unmanageable, and unachievable.

According to the aforementioned, it can be said that experts in the environment or closely linked sectors require a significant quantity of data, information, and knowledge at each step of the management and evaluation of environmental processes [5,13]. At the same time, they must be aware of and comprehend the circumstances in which these processes occur to plan and implement a project. The analysis conducted must be based on the best data, methods, and procedures that are currently accessible as well as on information obtained from one's own experience or that of other experts [5, 13]. According to current standards, this information and knowledge are typically acquired through direct access to databases, reports, and documents [5,13], through the sharing of information and knowledge between specialists (managers, practitioners, researchers, teachers, etc.), and at conferences and other specialized scientific events [14], which frequently emphasize the concept of sustainable community development [15,16].

Specialists must be able to manage and apply the ideas of environmental monitoring and assessment to improve management and environmental assessment. Only environmental information systems and a thorough grasp of the dynamics of socio-ecological systems can help us reach this aim [17]. As a result, they must have quick and easy access to current knowledge and information (in the form of huge open-access data) [18], enabling them to choose the optimal course of action for sustainable

development, in both established and developing countries.

Since ancient times, people have gathered documents of all kinds into collections and further investigated their contents. This activity is now regarded as a nearly natural development of humanity as it moves toward the development of a culture. We are concerned about how environmental information systems and environmental informatics will affect soil preservation [19-21]. We attempted to close these gaps through this research because Romania is known for the fact that the activity of soil protection through the lens of the tools provided by Environmental Information Systems is just beginning and that it demands an approach that is both complicated and multidisciplinary. The students and instructors from the environmental engineering departments of the nation's universities, engineers, computer scientists, and support staff engaged in specific soil protection activities are all potential recipients of the structured information generated during this research project. To highlight the malleability and affinity of the platform for the needs and demands of the digital consumer society, this paper begins by defining, describing, and synthesizing the App Inventor® platform developed by the Massachusetts Institute of Technology (MIT) based on users' perceptions from literature published in the previous 10-12 years.

## 2. MATERIALS AND METHODS

The creation and development of a digital application that looks like it belongs in the field are done concurrently with an investigation of how the MIT App Inventor® platform may be incorporated into contemporary soil protection tactics. The application needs the MIT App Inventor® platform to be connected to certain soil protection data (with the variation of texture, temperature, altitude and relief, relative humidity and atmospheric pressure, dynamics of local hydrometeorological characteristics, etc).

The analysis involved identifying and scoring factors that allow MIT App Inventor® to be used to create specific soil protection applications. It was carried out at the Office of Informatics within the North University Center of Baia Mare - Cluj-Napoca Technical University (Romania) during the reference period of October 2020 to December 2021. The analysis approach includes the key elements of mobile devices that might be

connected to the gathering and processing of field data regarding soils (camera and video camera, image picker, player, sound recording, navigation and map, barometer and hydrometer, accelerometer, orientation sensor, thermometer, and light sensor, etc).

Moreover, other key components were considered; this is how, by means of standardized tables, the possibilities of using the components of the user interface, media and sensors were also analyzed. Consequently, we can state with full confidence that the App Inventor® platform can be utilized successfully in contemporary environmental impact assessment strategies, but especially in monitoring and protecting soils, as a result of the configuration and pre-testing of the alternative application to the field agenda. In this approach, we advocate using MIT App Inventor®, a free tool with real-world applications that promises a better fusion of the two fields of interest, namely computer science and soil science, for individuals who wish or feel the need to create their application for soil or environmental protection.

## 3. RESULTS AND DISCUSSION

### 3.1 Digital Consumer Culture and the MIT App Inventor® Platform

We have access to a wide range of apps and opportunities for amusement, enjoyment, and occasionally even learning thanks to our consumer culture of digital content. But generally speaking, these are passive tasks [22-24] (see Fig. 1). The delight of generating, that is, developing content or applications, is in addition to the allure of consumption. When we paint, build a model, or create a completely functional mobile application, we feel joy and pride [25,26]. For the majority of us, the high-tech mobile devices we use today to get information and consume entertainment are opaque black boxes. Although some of them have features that let users create videos, draw pictures, or create new content, they are not in and of themselves creative environments due to the complexity of how they operate.

In other words, the majority of individuals are unable to develop applications for these devices [25,26]. What if we could alter that in the aforementioned sense? What if we had creative power over devices we use every day, like smartphones or tablets? What if developing a mobile app was as simple as taking a photo or

playing a game? It takes time to create a successful mobile application that reflects the viewpoint of a content provider and caters to the needs of your target market. Building an Android or iOS app requires a lot of work and takes a long time [27-29].

The majority of people think that developing mobile applications entails picking the best technology and working with a renowned firm. Making apps for the PlayStore® or App Store® requires just as much attention to detail as the correct management of the entire mobile app development process from beginning to end. It could first help to clarify such objects. They stop being opaque black boxes that are impenetrable to our imagination and creativity and start becoming tools that can be used to create and modify new material. They thus become something that we can grasp. When we can create apps specifically for each of us, our interaction with them becomes less passive and more creative, and we can play with these devices in a much deeper and more meaningful way [25]. The MIT App Inventor®, which may transform students from consumers into creators, also demonstrates the distinct motivational power that mobile devices may have in education.

Most people would be curious about the steps required in developing a mobile app after reading this eye-opening revelation. Market research, wireframing, technical feasibility analysis, prototyping, design, development, testing, and launch are the first steps in the development of a mobile application. Following are the promotion, support, and maintenance of the application. Even an experienced and skilled developer must pay attention at every stage to assure the sound and functioning of the application they have produced. Pregnancy does not happen overnight. The whole steps of the mobile app development process are listed below to help users throughout their application development journey:

- Market research - even though you may already have a ton of ideas for your mobile app, it's a good idea to learn more about target consumer demand, behavior patterns, and demographics. Not overlooking your competition is another critical aspect of this stage of the mobile app development process. You can learn the answers to the following questions by conducting in-depth research: Who are you trying to reach?

What will be the best platform for your app launch? What services do your rivals provide to customers? These are just a handful of the many inquiries that you must consider. Giving market research adequate time will lay a strong foundation for developing mobile applications.

- Wireframing is an important phase since it gives a clear idea of the features and operation of the program. Wireframing aids in focusing thoughts and properly arranging all of the application's components. Users are now attempting to determine how the intended features will integrate into a finished mobile app. By developing and streamlining the script to show how to utilize and explore the program, the primary goal should be to provide a superb user experience.
- In the technical feasibility assessment phase, it is determined whether or not the backend system can support the functionality of the application. Users must be aware that different systems and file types will require varying requirements from a program. Both the designers and the users will have different ideas for the functionality of the application by the end of this step.
- Prototyping enables the creative to assess whether or not they are heading in the right direction. To test how the application functions, a prototype is made that explains its concept to the intended audience.
- UI (User Interface) and UX (User Experience), which are still in the design phase, are seen as two essential elements of the mobile application (see Fig. 2). While the latter makes it easier for design elements to interact, the former is in charge of how the program looks and feels.
- As soon as the creator has to create a prototype to verify the features and functioning, the mobile app development phase starts. The development phase is further broken down into various stages where a team or individual developer creates code elements that are later tested by another team. The

development team continues after declaring the first segment error-free. It is wise to choose an agile methodology for complicated projects with shifting user needs since it promotes progressive development and planning process flexibility.

- The benefit of early and regular testing is that it allows developers to correct errors as soon as they arise. Consider compatibility, security, usability, performance, UI tests, and other elements when evaluating the program. Verify whether the application achieves its goals. You can ask a few users to use the app and provide comments so that you can test it in real time. You can be certain of the app's functionality after people like it.

- Implementing the application is not the final technical stage because you still need to make adjustments in response to input from your audience. Support and maintenance are the other two mobile application development phases that are still connected to a mobile application. It wouldn't be incorrect to claim that creating mobile applications is more of a long-term commitment than a quick endeavor.

According to the stages of mobile application development previously described, there have been numerous attempts over the years to streamline the software development process and enable more individuals to create applications. Another tool that can make software creation accessible to everyone rather than just a select group of experts is App Inventor® [23, 26].

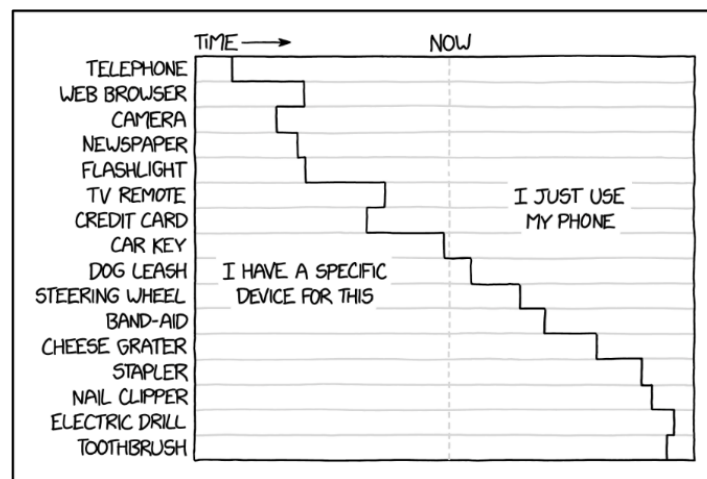
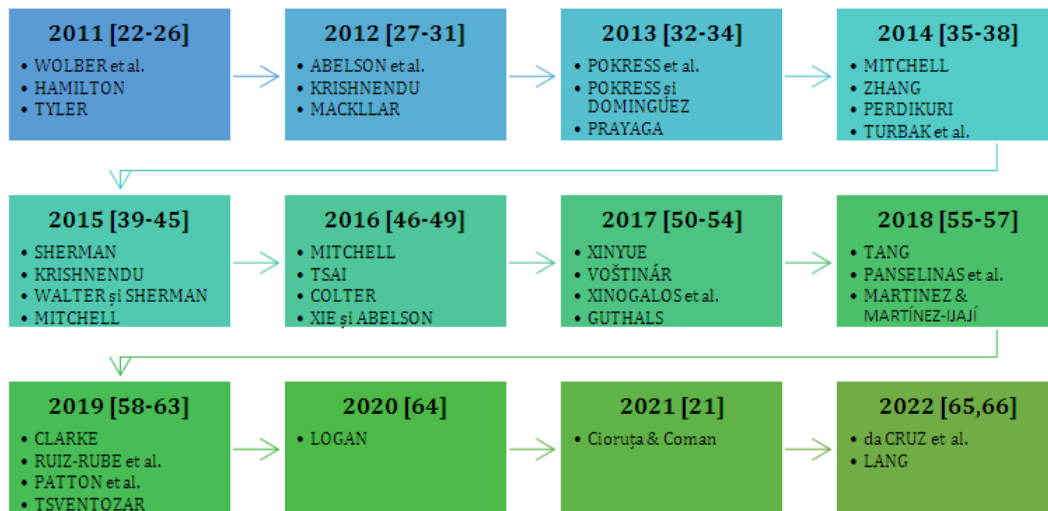


Fig. 1. A look at the current features of mobile phones [67]



Fig. 2. A perspective on mobile applications design



**Fig. 3. Examples of publications that support the usefulness of the MIT App Inventor® [67]**

Programming for mobile devices can offer a genuine and alluring hook in computer science as well as other applied sciences (ecology, pedology, agriculture, etc). Programming Android apps are as simple as clicking blocks together using MIT App Inventor®. In after-school learning programs, summer camps, and schools, as well as in experimental workshops for teachers and specific programs in classrooms from high school to college, the App Inventor® has been used successfully (see Fig. 3).

Over time, the MIT App Inventor® development environment has been defined in the scientific literature of the last 10-12 years as:

- “(...) a Google Labs® project that uses block editor technology and a drag-and-drop interface to enable users to create applications” [23];
- “(...) a visual language based on simple blocks of programming that users can drag and drop to create applications” [24];
- “(...) a new visual, drag-and-drop programming tool for building mobile applications on the Android platform” [25];
- “(...) a language of visual blocks for creating mobile applications, as part of a Google® pilot program, in a core curriculum at the University of San Francisco” [26];
- “(...) a visual programming environment developed by Google® and now available free of charge from the MIT Mobile Learning Center®, which allows students without prior programming training to create applications for Android mobile devices” [27];
- “(...) a language of visual blocks for building mobile applications; like Scratch®, the interface of language drag-and-drop blocks significantly reduces the entry barrier - beginners can immediately build applications that interact with mobile technology and create applications that have a real global impact” [28,29];
- “(...) the latest visual block programming language designed to introduce students to programming by creating mobile applications” [30];
- “(...) a new programming environment that allows novice programmers to build apps for Android mobile devices” [31];
- “(...) a visual drag-and-drop programming tool for designing and building fully functional mobile applications for Android” [32];
- “(...) a block-based visual programming language that makes sophisticated computing concepts accessible to a wide range of students” [33];
- “(...) a fun and intuitive visual programming environment that allows users to quickly and easily create applications that will run on the Android platform” [34];
- “(...) the fastest and easiest way to create custom Android apps (...) even if you have no previous programming experience; (...) can be used for personal, business, and commercial

applications - even applications to be sold in the Play Store<sup>®</sup> [35];

- “(...) a project inspired by MIT Media Lab’s Scratch Development System<sup>®</sup> [35];
- “(...) a visual programming environment for creating applications for Android-based smartphones and tablets. It is an alternative programming platform, quite easy, but also powerful, because it allows the development of applications using databases, interactive maps, and other advanced concepts and, most importantly, you do not have to write code” [36];
- “(...) a block-based language for specifying the behavior of mobile applications; its naming features (involving parameters and procedures, global and local variables, and names for procedures, components, and component properties) have been designed to address naming issues in other block languages” [37];
- “(...) an open-source code-free platform for application development using the drag-and-drop approach; provides an easy environment for non-programmers to create a mobile application” [38];
- “(...) a visual drag-and-drop programming for designing and building fully functional mobile applications for Android” and “an open-source web application originally provided by Google<sup>®</sup> and now maintained by the MIT<sup>®</sup>” [39];
- “(...) a mobile-based live development environment” [40];
- “(...) a quick way to create custom Android apps for smartphones or tablets” [41];
- “(...) the software development system running in your browser to create applications running on your smartphone and tablet” [42];
- “(...) a visual block language that allows beginners and non-programmers to create applications for their phones and tablets. It has allowed thousands of people to create useful software in the real world and to see themselves as creators rather than just consumers in the mobile computing environment” [43];
- “(...) one of the most popular block-based programming environments” [44];
- “(...) a programming environment that reduces barriers to the creation of mobile

applications for Android devices, especially for people with little or no programming experience. App Inventor applications for a mobile device are built by arranging components with a WYSIWYG editor in a web browser, where the development computer is connected to the device via WiFi or USB” [45];

- “(...) a visual language that allows users to create mobile apps for Android” [46];
- “(...) a quick and easy way to develop Android applications” [47];
- “(...) an easy-to-use tool for building both simple and complex Android applications that can be easily ported to your phone, shared with others, or even sent to the Google Play Store<sup>®</sup> for distribution on all Android devices in the whole world” [48];
- “(...) a programming language for Android apps designed to teach programming skills to middle and high school students” [49];
- “(...) an innovative tool, developed by Google<sup>®</sup> and maintained today by the MIT<sup>®</sup>; with it, you can create applications for Android mobile devices, through a visual language, without having to decorate or write programming language codes (...) an excellent learning tool that allows newcomers to computer programming to create complete applications” [50];
- “(...) a free online programming tool that uses simple block-style language that makes coding easy to learn” [51];
- “(...) a web-based visual platform for building Android applications” [52];
- “(...) a visual language, blocks for building Android applications, (...) which has tools for creating user interfaces and blocks, which collide and define how the application will work” [53];
- “(...) an informal online learning environment with over 5 million users and 15.9 million applications created” and “(...) an environment that uses block-based visual language to enable people to create mobile applications for Android devices” [54];
- “(...) a block-based programming environment that sets a «low stage» to allow creative creation of applications, while involving students in complex computational thinking activities (procedural abstraction and data, iterative and recursive thinking,

structured breakdown of tasks, conditional and logical thinking and debugging)” and “(...) a visual programming environment that uses Scratch-like code to build Android mobile applications” [55];

- “(...) a mobile application development platform that aims to democratize the construction of mobile applications by making application development accessible to people with little or no experience in script-based programming” [56];
- “(...) a visual programming environment that is similar to Scratch<sup>®</sup> and Alice<sup>®</sup>, which focuses more on mobile application development” and “(...) a block-based cloud programming tool that allows everyone to fully develop applications functional for Android devices” [57];
- “(...) a block-based open-source programming tool that allows users with no previous programming experience to create applications specifically for smartphones and mobile devices” [58];
- “(...) an online tool for creating mobile applications for the Android operating system; with this tool, it is possible to program applications without having to learn a programming language, an excellent approach that must be introduced in the development of applications” [59];
- “(...) an easy and visual application that allows you to develop Android applications even if you do not have programming knowledge” [60];
- “(...) a powerful programming environment, accessible to all” [61];
- “(...) a block-based mobile development tool” [62];
- “(...) an online platform designed to teach concepts of computational thinking through the development of mobile applications” [63];
- “(...) a free online visual programming environment, developed by Google<sup>®</sup> and now maintained by the MIT<sup>®</sup>; it allows people to create software for their phones and tablets, rather than just using those devices” [64];
- “(...) an online visual environment that uses the blockchain programming paradigm, which allows even users unfamiliar with programming languages

to quickly develop mobile applications running the Android operating system” [65];

- “(...) a free and revolutionary online program from MIT<sup>®</sup> that allows you to create your mobile apps” and “(...) matching easy-to-use code blocks allow even beginners to quickly create apps work” [66].

In the sense of the above, we define the MIT App Inventor<sup>®</sup> platform as “a new visual drag-and-drop programming tool/environment or informal web-based platform that allows users - non-programmers, beginners, or novice programmers - to create applications for Android mobile devices”.

### 3.2 MIT App Inventor<sup>®</sup> and its Soil Protection Features

In most operations today, digitization and mobile technology are evident components. It is crucial to understand not just the fundamental functioning and user interfaces of devices but also the fundamental concepts of computing, regardless of a professional's area of specialty or areas of interest [65]. By practicing with fully functional programs, block-based visual programming environments like Scratch<sup>®</sup> or MIT App Inventor<sup>®</sup> are frequently used to teach computer science to beginners and non-computer users alike (see Fig. 4).

A seasoned developer with years of Java experience could find the utility of the MIT App Inventor<sup>®</sup> to be debatable. How does App Inventor<sup>®</sup> work? It enables us to comprehend the difficulties that both producers and users encounter and provides context to aid upcoming software developers in moving forward. It's only a matter of time before you're approached with a demo or prototype created with App Inventor<sup>®</sup> if you work professionally with Java or Android. Anyone can utilize the MIT App Inventor<sup>®</sup> at no cost. Any browser can access it, and it operates online rather than on your machine directly. It may also be used without a phone because it comes with an Android emulator you can use to test your apps. Components are used to build MIT App Inventor<sup>®</sup> applications. The latter enables mobile applications to use web services or built-in mobile device functions like a camera, microphone, and location sensor. The platform development team adds new functionality to the system by integrating new components into the extensive library of components that make up MIT App Inventor<sup>®</sup> (see Fig. 5).





**Fig. 4. The top 5 defining elements of the MIT App Inventor®**

There have been numerous requests for the MIT App Inventor® to have more features. The MIT App Inventor® platform allows anyone to create their components, but up until this point, the only method to make them publicly accessible was to include them in personal versions of the application that were hosted and controlled separately. To help people who have specific concerns about soil conservation (practicing ecologists, farmers, agricultural area managers, etc.), we set out to expose two mobile application development environments (App Inventor® & Bridge to Java®), along with an app made in each of these settings.

Additionally, the "characterization of the relief-climate-vegetation units" functionalities required consulting the expert literature (Tables 1 & 2). Consequently, utilizing the ecopedological indicators chosen from the "Methodology of elaboration of pedological studies" published in 1987, with later changes, applications required for the zonal categorization of the sites were built and validated.

The outcomes of a recent study were used to expand upon and improve the ecopedological indicators. They're meant to guarantee a

consistent format, as well as a consistent, orderly recording and presentation of field observations on soils. The application that is being suggested for usage captures several work displays, each of which has a different set of features that flow from the main screen (Fig. 6).

A "soil sampling sheet" is automatically completed as the application's first feature (Fig. 7). This facility now includes "procedures for soil texture field recognition" (Fig. 8), "soil texture determination in pedology/agrochemistry laboratories," and "characterization of relief-climate-vegetation units" using ecopedological indicators chosen from the Methodology of pedological investigations.

The elements that can be utilized to build mobile applications for soil monitoring and protection in MIT App Inventor® are described below (see Figs. 6 and 7). The properties, events, and methods of each component are all possible. Most properties contain blocks that you may use to retrieve and set values, thus programs can change most of these properties (see Table 3). Applications are not allowed to update some attributes since they only include blocks that can be used to get values, not to set them (see Table 4).

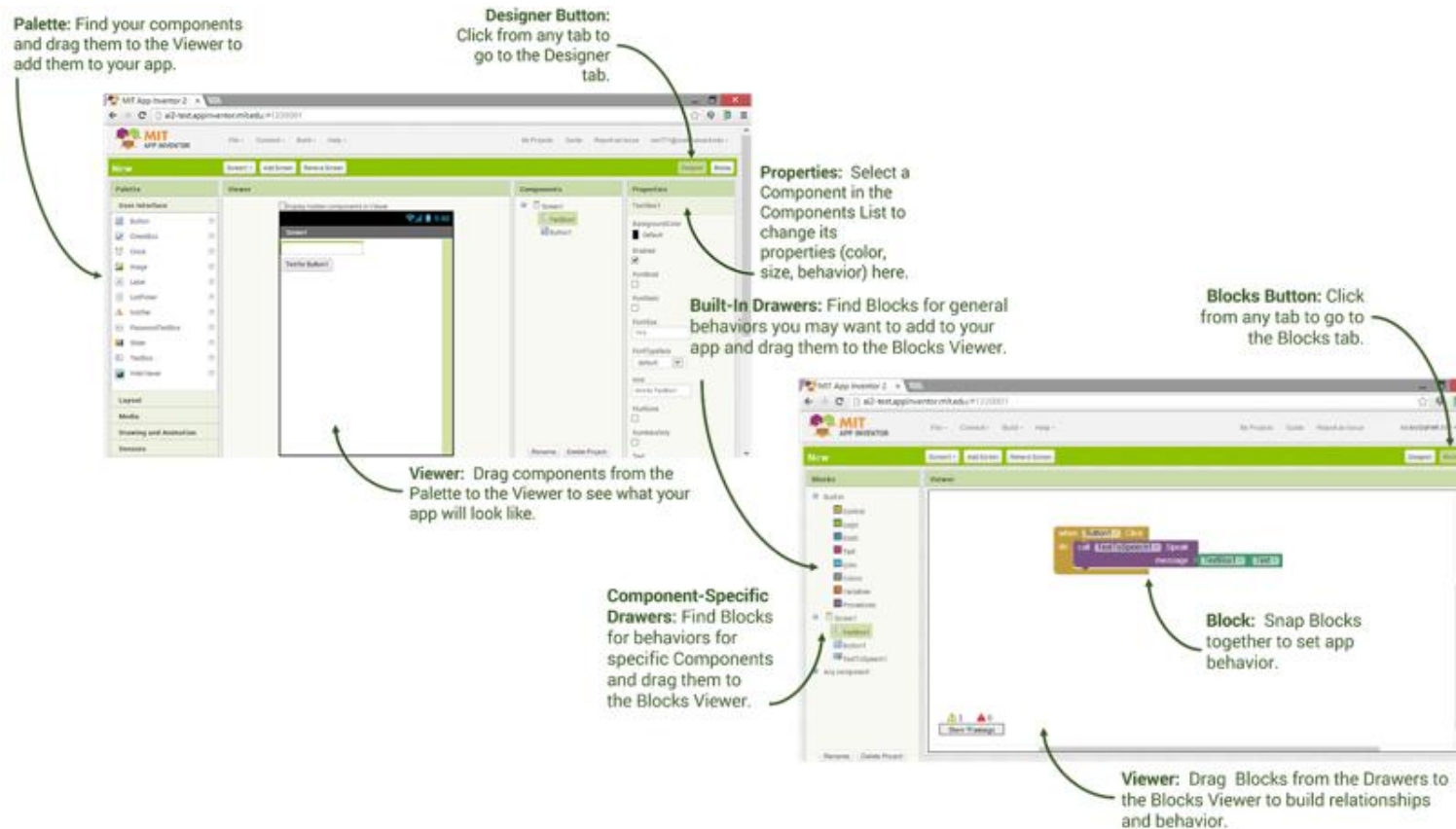


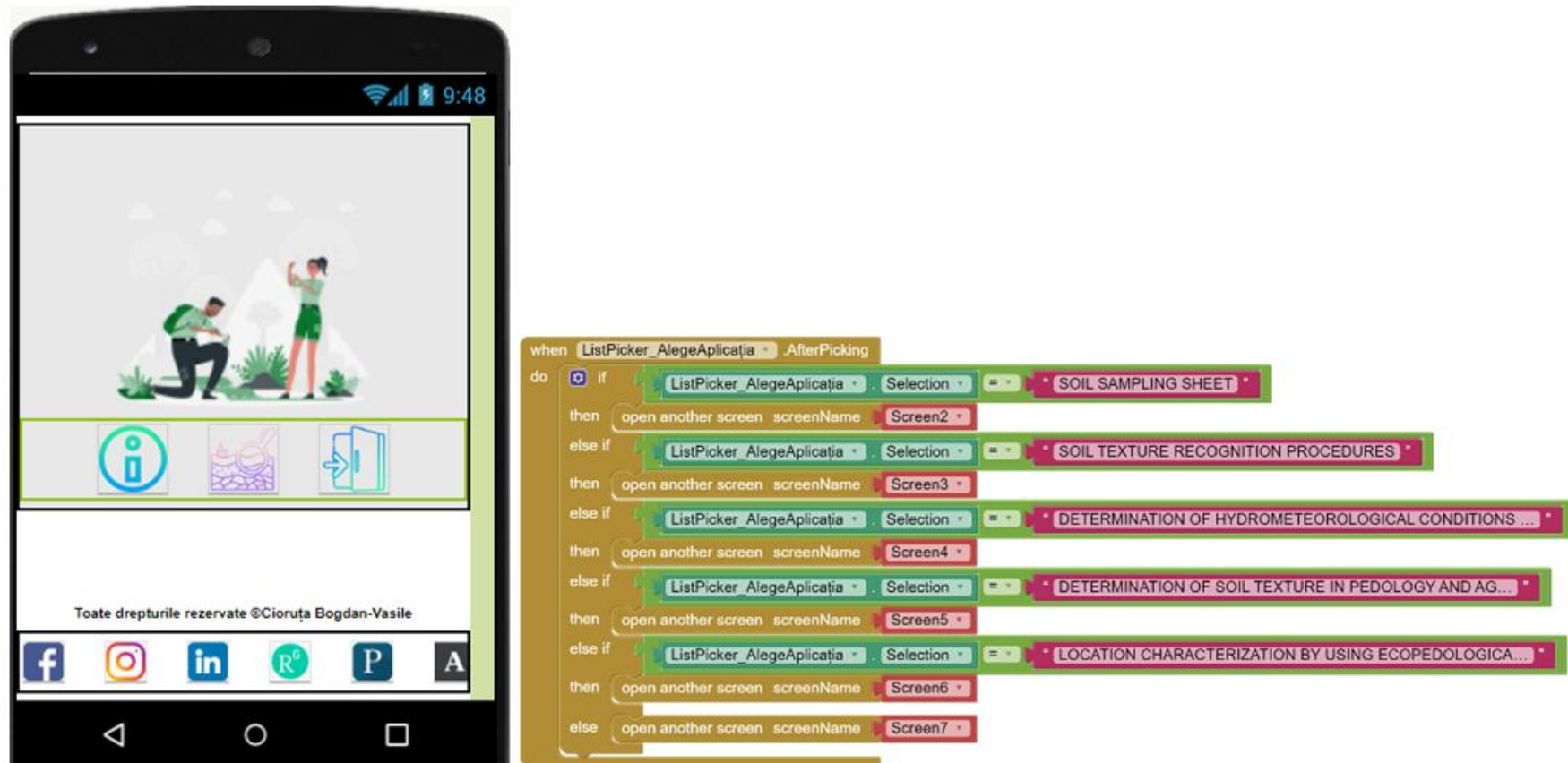
Fig. 5. Description of App Inventor® specific screens: Designer and Blocks Editor

**Table 1. Main characteristics of climatic zones (reproduction with changes, [67])**

Climatic zone	Average annual temperature, (°C)	Solar radiation, kcal/cm <sup>2</sup>	$\Sigma T(^{\circ}\text{C}) > 0^{\circ}\text{C}$ $\Sigma T(^{\circ}\text{C}) > 10^{\circ}\text{C}$	Average annual rainfall, mm	Average precipitation IV-X, mm
Warm-Dry zone	10.5-11.5	124-132	4100-4400 3500-3600	400-600	150-330
Moderately warm and semi-dry zone	8.0-10.5	114-128	3400-4100 2800-3500	450-700	325-475
Cool-Wet zone	5.0-9.0	110-117	2900-3500 2400-3000	550-800	380-560
Very wet and cold zone	-2.0-6.0	<110	<2900 <2400	800-1400	>560

**Table 2. Characteristics of the relief categories (reproduction with modifications, [67])**

Symbol	Designation	Characteristic			Correlation with the main relief forms
		predominant slope, %	fragmentation density	relief energy, m	
L	Meadow relief (alluvial plain)	<1	extremely weak	<10	Meadow, wandering plain, coastal plain
S	Plain relief	<2(3)	very weak	10-50 frec. 10-25 local 50-80	Plain (including terrace), plateau and foothills, unfragmented or slightly fragmented
O	Wavy relief	2(3)-5(8)	weak	50-150	Plain (including terrace), plateau and foothills, poorly fragmented
C	Slightly rugged terrain	5(8)-12(18)	moderate	150-300	Moderately fragmented hill, plateau, and foothills
D	Moderately rugged terrain	12(18)-20(30)	strong	300-500	Highly fragmented hill, plateau, and foothills
M	Strongly rugged terrain	>20(30)	very strong	>500	Mountain



**Fig. 6. The main screen of the created application:**  
a) the application interface in App Inventor®;  
b) the source code of the application interface in App Inventor - Bridge to Java®

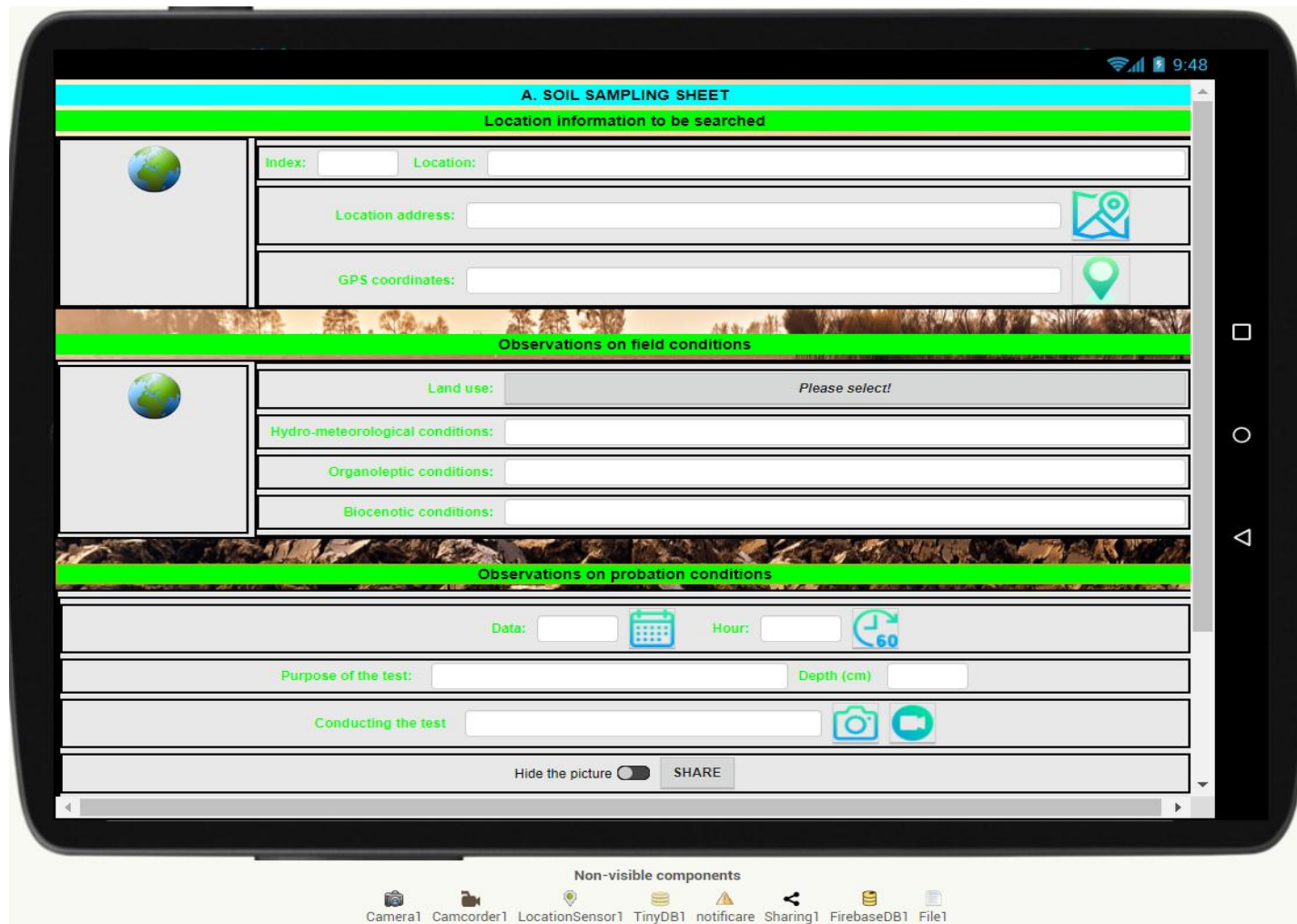


Fig. 7. The soil sampling sheet screen of the created application in MIT app inventor®

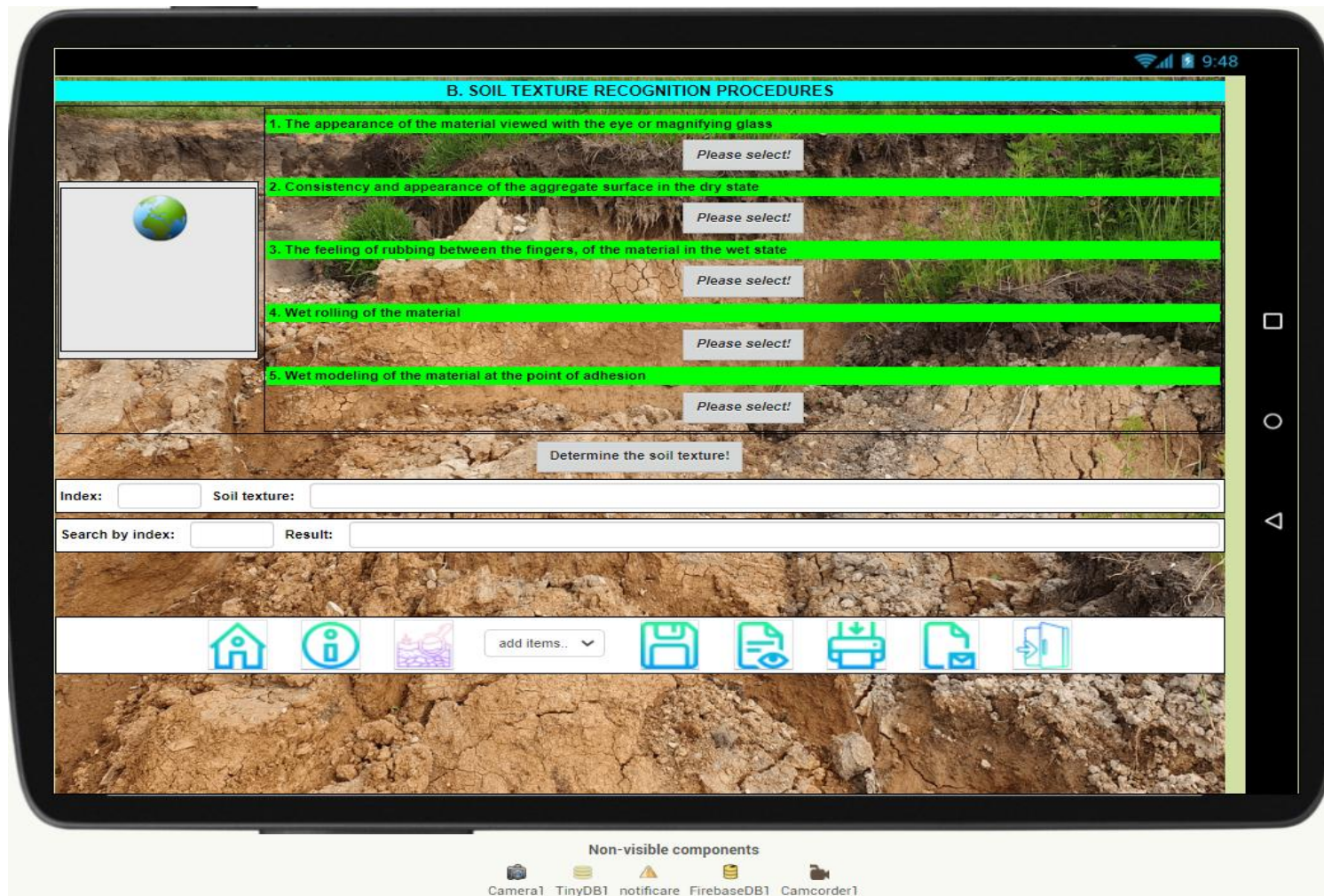


Fig. 8. The Soil Texture Recognition Procedures screen of the created application in MIT app inventor®

**Table 3. User Interface components: typology, features, and functionalities to the soil monitoring and protection activities**

Components	Properties	Soil monitoring and protection activities		
		soil classification	determination of specific properties*	other observations**
Button	Its properties can be changed in the Designer or the Blocks Editor.	xx	xxx	x
CheckBox	A button that allows the user to select a date on the Gregorian Calendar.	x	xx	x
DatePicker	Its properties can be changed in the Designer or the Blocks Editor.	xx	xxx	xx
Image	A button that displays a list of texts for the user to choose among.	xx	xxx	x
Label	A component that displays a list of text and image elements.	xx	xx	x
ListPicker	A component that displays alert messages.	x	xx	xx
ListView	Users enter passwords in a component that hides the text.	x	x	x
Notifier	A component that contains all other components.	x	xxx	xx
Password TextBox	A Slider is a progress bar that adds a draggable thumb.	x	xx	xx
Screen	A Spinner component displays a dialog with a list of elements.	x	x	x
Slider	A Switch component raises an event when the user taps it to toggle between states.	x	xx	xx
Spinner	Text boxes are usually used with the Button component.	x	xxx	xx
Switch	A button that opens a dialog to allow the user to select a time.	x	xx	xx
TextBox	Component for viewing Web pages.	x	xx	xx

\* soil texture, color, density, humidity, temperature, etc; \*\* local conditions (weather, relief, etc), or other conditions which require access and connection to external devices and additional sensors

**Table 4. Media and sensor components: typology, features, and functionalities to the soil monitoring and protection activities**

Components	Properties	Soil monitoring and protection activities		
		Soil classification	Determination of specific properties*	Other observations**
Camcorder	A component to record a video using the device's camcorder.	XX	XX	X
Camera	Use a camera component to take a picture.	XX	XXX	X
ImagePicker	A special-purpose button.	XX	XX	X
Player	A multimedia component that plays audio and controls phone	?	X	X
Sound	vibration.	?	X	X
SoundRecorder	A multimedia component that records audio.	?	X	?
Speech Recognizer	Use a SpeechRecognizer component to listen to the user speaking and convert the spoken sound into text.	?	X	X
TextToSpeech	Its properties can be changed in the Designer or the Blocks	X	X	X
VideoPlayer	Editor.	XX	XX	X
Yandex Translate		X	X	X
Accelerometer Sensor	A component that detects shaking and measures acceleration in 3 dimensions.	?	X	X
Barcode Scanner	-	?	?	?
Barometer	-	?	XX	XX
Clock	-	?	X	?
Gyroscope Sensor	-	?	X	?
Hygrometer	-	?	X	X
LightSensor	-	X	X	?
Location Sensor	A component that provides the device's location, using GPS if available.	XX	XXX	XX
Magnetic FieldSensor	-	?	?	?
NearField	-	?	?	?
Orientation Sensor	A component that determines the phone's spatial orientation	X	XX	X
Pedometer	This component keeps a count of steps using the accelerometer.	?	XX	X
Proximity Sensor	A component that can measure the proximity of an object (in cm) relative to the view screen of a device	?	?	?
Thermometer	-	?	X	X

\* soil texture, color, density, humidity, temperature, etc; \*\* local conditions (weather, relief, etc), or other conditions which require access and connection to external devices and additional sensors



The application under consideration for deployment is based on the concept of completing the field agenda for recording observations on soil characteristics, with some of its design elements echoing the user's research (small farmer, ecologist, pedologist, student practitioner, etc). A precise set of instructions must be defined for each component of the interface in light of the block editor to finalize the application's behavior because the application in its current version (by design only) does not produce any outcomes.

From the analysis carried out on the various specific components of the user interface, which the MIT App Inventor® platform makes available for the development of new applications (see Table 3), we noticed that the most useful components (with xxx) are those that ensure the user interface (Button, Image, Label, ListPicker, Screen and TextBox); they lend themselves very well to the requirements related to determining the specific properties of soils (texture, color, density, humidity, temperature, etc.).

The media and sensors components that serve the MIT App Inventor® platform behave in a similar way (see Table 4), in the sense that they are more than necessary for determining the specific properties of soils (through the camera, location/geolocation and proximity sensors, etc.). At the opposite pole (in correlation with Table 3 and Table 4), with reduced or limited use in terms of the creation and implementation of new applications (concerning soil classification and other specific aspects) there are Password TextBox and Spinner components (user interface components), respectively SoundRecorder, Barcode Scanner, Clock, Gyroscope Sensor, LightSensor, Magnetic FieldSensor, NearField, and Proximity Sensor (media and sensors components).

#### 4. CONCLUSION

A comprehensive strategy that must include mobile technology must be used for soil monitoring and protection, as well as for field work done by experts or workers with concerns in the field. The latter's intrusion must also be made with tools that enable more effective management of the collection, processing, storage, and transmission of information on soils (from a simple picture to determine the texture and color of soils to specific aspects, nuance, field conditions, and soil classification).

We were able to identify that there is a historical framework, well nuanced, of issues for soil monitoring and protection through mobile devices and associated software as a result of reviewing the literature (particularly from the previous 10-12 years). To assess and see how technology may be included in soil conservation measures, we used the App Inventor® platform as an example in the last category. This platform is used for the development of Android and iOS mobile applications. We, therefore, set out to investigate the features that mobile application development platforms allocate to mobile applications starting with the components it makes available (albeit we only chose the ones connected to the user interface and the media). As such, the research findings have demonstrated that there is a well-defined set of components, features, and sensors that can be incorporated into mobile device-specific applications to aid in soil monitoring and protection (starting from the premise of using the MIT App Inventor® platform in soil protection). This means that data, information, and knowledge about land, land use, and the practice of systematic farming may be collected, stored, and shared using mobile devices.

Regarding the perspectives of development and improvement of the application created by us, we proposed (where appropriate) to expand the research area and implicitly to diversify the possibilities of acquisition, saving and/or storage of data from the field. In this sense, we have in mind for the future a series of measures to improve functionalities, to increase the degree of portability and to combine cross-platform software. All these elements can and will bring significant benefits in terms of the user interface, the possibilities of acquiring, processing, saving and/or storing data, as well as in the overall efficiency of the mobile application, intended not to replace or steal elements from the work the practitioner in the field, but to ensure a better service of research interests.

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## COMPETING INTERESTS

Authors have declared that no competing interests exist.

## REFERENCES

1. Haklay M. From environmental information systems to environmental informatics: evolution and meaning. Working paper. CASA Working Papers (7). London, UK; 1999. [Accesat la 06.04.2021]. Available: [www.researchgate.net/publication/32884900\\_From\\_environmental\\_information\\_systems\\_to\\_environmental\\_informatics\\_evolution\\_and\\_meaning](http://www.researchgate.net/publication/32884900_From_environmental_information_systems_to_environmental_informatics_evolution_and_meaning)
1. Cioruța B, Coman M. Incursiune în cercetarea științifică modernă a mediului înconjurător. De la Sistemele Informatice de Mediu la Informatica Mediului, Journal of Environmental Research and Protection, Universitatea Babeș-Bolyai Cluj-Napoca, ISSN tipărit 1584-7071, ISSN electronic 2248-3128, nr. 2011;29:17-20. [Accesat la 06.04.2021]. Available: [www.ecoterra-online.ro/files/1330955124.pdf](http://www.ecoterra-online.ro/files/1330955124.pdf)
2. Cioruța B, Coman M. Evoluția, definirea și rolul Sistemelor Informatice de Mediu în dezvoltarea strategiilor pentru protecția mediului, Journal of Environmental Research and Protection, Universitatea Babeș-Bolyai Cluj-Napoca, ISSN tipărit 1584-7071, ISSN electronic 2248-3128, nr. 2011;27:11-14. [Accesat la 06.04.2021]. Available: [www.ecoterra-online.ro/files/1321371401.pdf](http://www.ecoterra-online.ro/files/1321371401.pdf)
3. Tîrziman E Informația și formarea universitară, Editura Tehnică, București; 2003.
4. Cioruța B, Cioruța A, Coman M. Pledoarie pentru necesitatea formării unei culturi informaționale environmentale, Journal of Environmental Research and Protection (ECOTERRA®), Universitatea Babeș-Bolyai Cluj-Napoca, ISSN tipărit 1584-7071, ISSN electronic 2248-3128, nr. 2012;30:31-39. [Accesat la 06.04.2021]. Available: [www.ecoterra-online.ro/files/1339069625.pdf](http://www.ecoterra-online.ro/files/1339069625.pdf)
5. Avouris NM, Page B. Environmental Informatics: Methodology and Applications of Environmental Information Processing, Kluwer Academic, Boston; 1995.
6. Hilty LM, Page B, Radermacher FJ, Riekert WF. Environmental Informatics as a New Discipline of Applied Computer Science. 1995;978-94-017-1443-3\_1. Available: [www.researchgate.net/publication/Environmental\\_Informatics\\_as\\_a\\_New\\_Discipline\\_of\\_Applied\\_Computer\\_Science](http://www.researchgate.net/publication/Environmental_Informatics_as_a_New_Discipline_of_Applied_Computer_Science)
7. Cioruța B, Coman M, Cioruța A. GeoGebra software - a new possibility for studying the environmental problematics?, Journal of Environmental Research and Protection (ECOTERRA®), Universitatea Babeș-Bolyai Cluj-Napoca, ISSN tipărit 1584-7071, ISSN electronic 2248-3128, nr. 2012;30:40-47. [Accesat la 06.04.2021]. Available: [www.ecoterra-online.ro/files/1339069750.pdf](http://www.ecoterra-online.ro/files/1339069750.pdf)
8. Cioruța B, Coman M, Tamașoschi M. Considerations on the implications of environmental information systems in hydro-meteorological forecast, Conferința Internațională „Aerul și Apa – componente ale mediului”®, 23-24 martie 2012, Cluj-Napoca, Editura Presa Universitară Clujeană. 2012;519-526. [Accesat la 06.04.2021]. Available: <http://aerapa.conference.ubbcluj.ro/2012/pdf/69%20cioruta.pdf>
9. Coman M, Cioruța B. Applications of environmental information systems in the hydrometeorological forecast, International Conference “Scientific Research and Education in the Air Force” (AFASES®), 24-26 mai 2012, “Henri Coandă” Air Force Academy, Brașov. 2012;803-808. [Accesat la 06.04.2021]. Available: [www.afahc.ro/afases/volum\\_afases\\_2012.pdf](http://www.afahc.ro/afases/volum_afases_2012.pdf)
10. Coman M, Cioruța B. Environmental information systems as a possible solution for strategic development of local and regional communities, Conferința Internațională „Aerul și Apa - componente ale mediului”®, 22-23 martie 2013, Cluj-Napoca, Editura Presa Universitară Clujeană, ISSN/EISSN: 2067-743X. 2013; 516-523. [Accesat la 06.04.2021]. Available: [http://aerapa.conference.ubbcluj.ro/2013/pdf/66coman\\_cioruta\\_516\\_523.pdf](http://aerapa.conference.ubbcluj.ro/2013/pdf/66coman_cioruta_516_523.pdf)
11. Cioruța B, Coman M, Mateșan V. Environmental information systems: solutions and emerging challenges for the

- modern strategic development of Romanian local communities. International Conference "Scientific Research and Education in the Air Force" (AFASES<sup>®</sup>), 23-25 mai 2013, Brașov. 2013;372-375. [Accesat la 06.04.2021]. Available: [www.afahc.ro/ro/afases/2013/eng\\_el/Ciotuta\\_Coman\\_Matesan.pdf](http://www.afahc.ro/ro/afases/2013/eng_el/Ciotuta_Coman_Matesan.pdf)
12. Cioruța B, Coman M. From enviromatics to sustainable informatics: beyond the definition and conceptual delimitations. *Ecological Safety and Balanced Use of Resources*, 2019;1(19): 7-18. [Accesat la 06.04.2021]. Available: [https://doi.org/10.31471/2415-3184-2019-1\(19\)-7-18](https://doi.org/10.31471/2415-3184-2019-1(19)-7-18)
  13. Avouris N. Human interaction with environmental information systems. *Interdisciplinary Environmental Review*. 2001;3:134 - 144. Available: [www.researchgate.net/publication/264812313\\_Human\\_interaction\\_with\\_environmental\\_information\\_systems](http://www.researchgate.net/publication/264812313_Human_interaction_with_environmental_information_systems)
  14. Cioruța B, Coman M, Cioruța A, Luran A. From human-environment interaction to environmental informatics (I): Theoretical and practical implications of knowledge-based computing, magazine of hydraulics, pneumatics, tribology, Ecology, Sensorics, Mechatronics (Hidraulica<sup>®</sup>), nr. 1/2018. 2018;71-82. [Accesat la 06.04.2021]. Available: <https://hidraulica.fluidas.ro/2018/nr1/71-82.pdf>
  15. Cioruța B, Coman M, Luran A. From human-environment interaction to environmental informatics (II): the sustainability evolution as a requirement of knowledge-based society, magazine of hydraulics, pneumatics, tribology, ecology, sensorics, mechatronics (Hidraulica<sup>®</sup>), nr. 2018;2:33-42. [Accesat la 06.04.2021]. Available: <https://hidraulica.fluidas.ro/2018/nr2/33-42.pdf>
  16. Coman M, Cioruța B. From human-environment interaction to environmental informatics (III): the social-ecological systems dynamics in knowledge-based society, magazine of hydraulics, pneumatics, tribology, ecology, sensorics, mechatronics (Hidraulica<sup>®</sup>), nr. 2018; 1:124-134. [Accesat la 06.04.2021]. Available: <https://hidraulica.fluidas.ro/2019/nr1/124-134.pdf>
  17. Cioruța A, Cioruța B, Coman M. From human-environment interaction to environmental informatics (IV): filling the environmental science gaps with big open-access data, magazine of hydraulics, pneumatics, tribology, ecology, sensorics, mechatronics (Hidraulica<sup>®</sup>), nr. 2019;2:52-61. [Accesat la 06.04.2021]. Available: <https://hidraulica.fluidas.ro/2019/nr2/52-61.pdf>
  18. Hreniuc M, Cioruța B, Coman M. An insight into the history of scientific concerns about soil pollution in Maramures County. *Journal of Documentation, Research and Professional Training (ProEnvironment<sup>®</sup>)*, print ISSN: 1844-6698, electronic ISSN: 2066-1363. 2019;12(38):142-149. [Accesat la 06.04.2021]. Available: <http://journals.usamvcluj.ro/index.php/promediu/article/view/13643/11231>
  19. Cioruța B, Coman M. Considerations regarding the implications of mobile-based Environmental Information Systems in contaminated soils characterization, *Journal of Documentation, Research and Professional Training (ProEnvironment<sup>®</sup>)*, Print ISSN: 1844-6698, Electronic ISSN: 2066-1363. 2019;12(38):127-131. [Accesat la 06.04.2021]. Available: <http://journals.usamvcluj.ro/index.php/promediu/article/view/13638/11227>
  20. Cioruța B, Coman M. Implications of mobile-based information systems in contaminated soils characterization, natural resources and sustainable development (NRSD<sup>®</sup>). 2021;11(2):135-142. [Accesat la 01.12.2021]. Available: [www.nrsdj.com/issues-year-2021-2/implications-of-mobile-based-information-systems-in-contaminated-soils-characterization.html](http://www.nrsdj.com/issues-year-2021-2/implications-of-mobile-based-information-systems-in-contaminated-soils-characterization.html)
  21. Jordan L, Greyling P. App Inventor. Available: [http://www.researchgate.net/publication/251415539\\_App\\_Inventor](http://www.researchgate.net/publication/251415539_App_Inventor). In: *Practical android projects*. Berkeley, CA: Apress; 2011.
  22. Hamilton E. Tech empowerment: android app Inventor. Lulu press Raleigh, North Carolina; 2011. Available: [https://books.google.ro/books?id=PXTGAQAAQBAJ&printsec=frontcover&dq=App+Inventor&hl=ro&sa=X&redir\\_esc=y#v=onepage&q=App%20Inventor&f=false](https://books.google.ro/books?id=PXTGAQAAQBAJ&printsec=frontcover&dq=App+Inventor&hl=ro&sa=X&redir_esc=y#v=onepage&q=App%20Inventor&f=false)

23. Tyler J. App inventor. for android. Build Your Apps Experience Required! ; 2011. Available:[https://play.google.com/store/books/details/App\\_Inventor\\_for\\_Android\\_Build\\_Your\\_Own\\_Apps\\_No\\_Ex?id=8ZKvZHBxjYYC&gl=US](https://play.google.com/store/books/details/App_Inventor_for_Android_Build_Your_Own_Apps_No_Ex?id=8ZKvZHBxjYYC&gl=US).
24. Wolber D. App inventor and real-world motivation. 2011;601-606. DOI: 10.1145/1953163.1953329 Available:[http://www.researchgate.net/publication/234815054\\_App\\_inventor\\_and\\_real-world\\_motivation](http://www.researchgate.net/publication/234815054_App_inventor_and_real-world_motivation).
25. Wolber D, Abelson H, Spertus E, Looney L. App inventor - create your own android apps; 2011. Available:[http://www.cs.usfca.edu/~wolber/appinventor/appinv\\_0331.pdf](http://www.cs.usfca.edu/~wolber/appinventor/appinv_0331.pdf).
26. Abelson H, Mustafaraj E, Turbak F, Morelli R, Uche C. Lessons learned from teaching App Inventor. *J Comput Sci Colleges*. 2012;27:39-41.
27. Abelson H, Wolber D, Morelli R, Gray J, Uche C. Teaching with app inventor for android. DOI:10.1145/2157136.2157437; 2012. Available:[http://www.researchgate.net/publication/254007525\\_Teaching\\_with\\_app\\_inventor\\_android](http://www.researchgate.net/publication/254007525_Teaching_with_app_inventor_android).
28. Gray J, Abelson H, Wolber D, Friend M. Teaching CS principles with app inventor. DOI:10.1145/2184512.2184628; 2012. Available:[http://www.researchgate.net/publication/241623955\\_Teaching\\_CS\\_with\\_app\\_inventor](http://www.researchgate.net/publication/241623955_Teaching_CS_with_app_inventor).
29. Roy K. App inventor for android: report from a summer camp. *Proceedings of the 43rd ACM Technical Symposium on Computer Science Education*. 2012; 12:283-8.
30. Mackellar B. App inventor for android in a healthcare IT course. *Proceedings of the ACM special interest group for Information Technology Education Conference*. 2012; 12:245-50.
31. Pokress S, Dominguez Veiga JJ. App MIT. Inventor: Enabling personal mobile computing; 2013. Available:[http://www.researchgate.net/publication/257592032\\_MIT\\_App\\_Inventor\\_Enabling\\_Personal\\_Mobile\\_Computing](http://www.researchgate.net/publication/257592032_MIT_App_Inventor_Enabling_Personal_Mobile_Computing).
32. Morelli R, Wolber D, Pokress S, Turbak F, Martin F. Teaching the CS principles curriculum with app inventor (abstract only). Inventor; 2013. Available:[http://www.researchgate.net/publication/250243218\\_Teaching\\_the\\_CS\\_principles\\_curriculum\\_with\\_App\\_Inventor](http://www.researchgate.net/publication/250243218_Teaching_the_CS_principles_curriculum_with_App_Inventor).
33. Prayaga L. Android app; 2013. Inventor for the Absolute Beginner, Cengage Learning PTR. Available:[https://books.google.ro/books?id=HwDOmQEACAAJ&hl=ro&source=gbs\\_book\\_other\\_versions](https://books.google.ro/books?id=HwDOmQEACAAJ&hl=ro&source=gbs_book_other_versions).
34. Mitchell E. App inventor 2 [introduction]: Step-by-step guide to creating Android apps the easy way. 2014;1. Available:[https://play.google.com/store/books/details/Edward\\_Mitchell\\_MS\\_MBA\\_App\\_Inventor\\_2\\_Introduction?id=sPlfBQAAQBAJ](https://play.google.com/store/books/details/Edward_Mitchell_MS_MBA_App_Inventor_2_Introduction?id=sPlfBQAAQBAJ).
35. Perdikuri K. Students' experiences from the use of MIT app Inventor in classroom. *Inventor in the Classroom*; 2014. Available:[http://www.researchgate.net/publication/280077205\\_Students%27\\_Experiences\\_from\\_the\\_use\\_of\\_MIT\\_App\\_Inventor\\_in\\_classroom](http://www.researchgate.net/publication/280077205_Students%27_Experiences_from_the_use_of_MIT_App_Inventor_in_classroom)
36. Turbak F, Wolber D, Medlock-Walton P. The design of naming features in App Inventor 2. *Inventor*. 2014;2:129-32.
37. Zhang C. Healthcare mobile app development with app. Inventor in a Health IT Course; 2014. Available:[http://www.researchgate.net/publication/263850796\\_Healthcare\\_Mobile\\_App\\_Development\\_with\\_App\\_Inventor\\_in\\_a\\_Health\\_IT\\_Course](http://www.researchgate.net/publication/263850796_Healthcare_Mobile_App_Development_with_App_Inventor_in_a_Health_IT_Course).
38. Amerkashi H. Absolute app Inventor 2. *Android Programming for all Ages*. 2015;1.. Available:[https://play.google.com/store/books/details/Hossein\\_Amerkashi\\_Absolute\\_App\\_Inventor\\_2?id=Q4GxBgAAQBAJ](https://play.google.com/store/books/details/Hossein_Amerkashi_Absolute_App_Inventor_2?id=Q4GxBgAAQBAJ).
39. Roy K. Position statement: app inventor instructional resources for creating tangible apps. Available:[http://www.researchgate.net/publication/308602321\\_Position\\_statement\\_App\\_inventor\\_instructional\\_resources\\_for\\_creating\\_tangible\\_apps](http://www.researchgate.net/publication/308602321_Position_statement_App_inventor_instructional_resources_for_creating_tangible_apps); 2015.
40. Mitchell E. App Inventor 2 Advanced Concepts: Step-by-step guide to Advanced features including TinyDB. 2015;2. Available:[http://play.google.com/store/books/details/Edward\\_Mitchell\\_MS\\_MBA\\_App\\_Inventor\\_2\\_Advanced\\_Con?id=QCB4CgAAQBAJ](http://play.google.com/store/books/details/Edward_Mitchell_MS_MBA_App_Inventor_2_Advanced_Con?id=QCB4CgAAQBAJ).
41. Mitchell E. AppInventor 2 databases and files: Step-by-step guide to TinyDB. TinyWebDB. Fusion Tables and Files. 2015;3. Available:[https://play.google.com/store/books/details/Edward\\_Mitchell\\_MS\\_MBA\\_App](https://play.google.com/store/books/details/Edward_Mitchell_MS_MBA_App)

- p\_Inventor\_2\_Databases\_an?id=ryB4CgAAQBAJ
42. Sherman M. Process-oriented assessment of development in-app inventor. Available:[http://www.researchgate.net/publication/304285784\\_Process-oriented\\_assessment\\_of\\_development\\_in\\_app\\_inventor](http://www.researchgate.net/publication/304285784_Process-oriented_assessment_of_development_in_app_inventor); 2015.
  43. Walter D, Sherman M. Learning MIT app inventor - a hands-on guide to building your android apps. Pearson Education, Inc. ; 2015. Available:<https://ptgmedia.pearsoncmg.com/images/9780133798630/samplepages/9780133798630.pdf>.
  44. Wolber D, Abelson H, Friedman M. Democratizing computing with APP Inventor. *ACM SIGMOBILE Mob Comput Commun Rev.* 2015;18(4):53-8.
  45. Colter AJ. Evaluating and improving the Usability of MIT App. Inventor. ; 2016 Available:[http://www.researchgate.net/publication/311842698\\_Evaluating\\_and\\_improving\\_the\\_Usability\\_of\\_MIT\\_App\\_Inventor](http://www.researchgate.net/publication/311842698_Evaluating_and_improving_the_Usability_of_MIT_App_Inventor).
  46. Mitchell E, Torres MB, Joe J, Danh T, Gass B, Horvath KJ. Formative work to develop a tailored hiv testing smartphone app for diverse, at-risk, hiv-negative men who have sex with men: a focus group study. *JMIR Mhealth Uhealth.* Inventor 2 Graphics, Animation & Charts: Step-by-step guide to Graphics, Animation, and Charts. 2016;4(4):e128.
  47. Tsai S. Understanding app. Inventor Forums; 2016. Available Xie B, Abelson H. Skill progression in MIT app inventor. Available:[http://www.researchgate.net/publication/309917255\\_Skill\\_progression\\_in\\_MIT\\_app\\_inventor](http://www.researchgate.net/publication/309917255_Skill_progression_in_MIT_app_inventor); 2016.
  48. Gerbelli NF, Gerbelli VHP. App inventor: Seus primeiros aplicativos Android; 2017. Available:[https://play.google.com/store/books/details/Nelson\\_Fabbri\\_Gerbelli\\_App\\_Inventor?id=6CpBDwAAQBAJ](https://play.google.com/store/books/details/Nelson_Fabbri_Gerbelli_App_Inventor?id=6CpBDwAAQBAJ).
  49. Guthals S. Building a mobile app: Design and program your App!; 2017. Available:<http://www.goodreads.com/book/show/35581314-building-a-mobile-app>.
  50. Voštinár P. Using app inventor for creating educational applications. *Edulearn Proceedings.* 2017;10128-33.
  51. Xinogalos S, Satratzemi M, Malliarakis C. Microworlds, games, animations, mobile apps, puzzle editors and more: what is important for an introductory programming environment? *Educ Inf Technol.* 2017; 22(1):145-76.
  52. Xinyue D. Group collaboration with App Inventor. Massachusetts Institute of Technology; 2017. Available:[www.researchgate.net/publication/32196228\\_Group\\_collaboration\\_with\\_App\\_Inventor](http://www.researchgate.net/publication/32196228_Group_collaboration_with_App_Inventor).
  53. Martínez-Valdés JA, Martínez-Ijjá NA. An experience with the App Inventor in CS0 for the development of the STEM didactics. 2018;51-6. Available:[http://www.researchgate.net/publication/328975262\\_An\\_experience\\_with\\_the\\_App\\_Inventor\\_in\\_CS0\\_for\\_the\\_development\\_of\\_the\\_STEM\\_didactics](http://www.researchgate.net/publication/328975262_An_experience_with_the_App_Inventor_in_CS0_for_the_development_of_the_STEM_didactics). DOI: 10.1145/3284179.3284189.
  54. Panselinas G, Fragkoulaki E, Angelidakis N, Papadakis S, Tzagkarakis E, Manassakis V. Monitoring students' perceptions in an app inventor school course. 2018;5. *European Journal of Engineering Research and Science.* Available:[http://www.researchgate.net/publication/323647511\\_Monitoring\\_Students%27\\_Perceptions\\_in\\_an\\_App\\_Inventor\\_School\\_Course](http://www.researchgate.net/publication/323647511_Monitoring_Students%27_Perceptions_in_an_App_Inventor_School_Course).
  55. Tang L. Effects of multi-layered environments in learning app inventor; 2018. Available:[http://www.researchgate.net/publication/329773461\\_Effects\\_of\\_multi-layered\\_environments\\_in\\_learning\\_app\\_inventor](http://www.researchgate.net/publication/329773461_Effects_of_multi-layered_environments_in_learning_app_inventor).
  56. Cho K. Three-dimensional editor for app Inventor; 2019. Available:[http://www.researchgate.net/publication/340135535\\_Three-dimensional\\_editor\\_for\\_app\\_inventor](http://www.researchgate.net/publication/340135535_Three-dimensional_editor_for_app_inventor).
  57. Clarke N. Augmented reality components with MIT App. Inventor; 2019. Available:[http://www.researchgate.net/publication/337473431\\_Augmented\\_reality\\_components\\_with\\_MIT\\_App\\_Inventor](http://www.researchgate.net/publication/337473431_Augmented_reality_components_with_MIT_App_Inventor).
  58. Kodlab YAA. App inventor; 2019. Available:[https://play.google.com/store/books/details/Adem\\_AKYOL\\_APP\\_INVENTOR?id=5OW3DwAAQBAJ](https://play.google.com/store/books/details/Adem_AKYOL_APP_INVENTOR?id=5OW3DwAAQBAJ).
  59. Patton E, Tissenbaum M, Harunani F, 2019. App MIT. Inventor: Objectives, design, and development. Available:[http://www.researchgate.net/publication/337361811\\_MIT\\_App\\_Inventor\\_Objectives\\_Design\\_and\\_Development](http://www.researchgate.net/publication/337361811_MIT_App_Inventor_Objectives_Design_and_Development). doi: 10.1007/978-981-13-6528-7\_3.
  60. Ruiz-Rube I, Mota JM, Person T, Corral JMR, Dodero JM. Block-based

- development of mobile learning experiences for the Internet of things. Sensors (Basel, Switzerland). 2019; 19(24).
62. St. Georgiev T. Students' viewpoint about using MIT app inventor in education. Inventor in Education. 2019;611-6. Available:[http://www.researchgate.net/publication/334421945\\_Students%27\\_Viewpoint\\_about\\_Using\\_MIT\\_App\\_Inventor\\_in\\_Education](http://www.researchgate.net/publication/334421945_Students%27_Viewpoint_about_Using_MIT_App_Inventor_in_Education). doi: 10.23919/MIPRO.2019.8756671.
63. Logan BL. Learn to program with app. Inventor: a Visual Introduction to Building Apps; 2020. Available:[https://books.google.ro/books?id=Z1v6DwAAQBAJ&pg=PR18&dq=App+Inventor&hl=ro&sa=X&ved=2ahUKEwjBq9-ouKf2AhVGQ\\_EDHYBZBy44ChDoAXoECAlQAq](https://books.google.ro/books?id=Z1v6DwAAQBAJ&pg=PR18&dq=App+Inventor&hl=ro&sa=X&ved=2ahUKEwjBq9-ouKf2AhVGQ_EDHYBZBy44ChDoAXoECAlQAq).
64. da Cruz AN, Grasse E, von Wangenheim C, Hauck J, Borgatto A. Automating the assessment of algorithms and programming concepts in app. Inventor Projects in Middle School; 2022. Available:[http://www.researchgate.net/publication/357487070\\_Automating\\_the\\_Assessment\\_of\\_Algorithms\\_and\\_Programming\\_Concepts\\_in\\_App\\_Inventor\\_Projects\\_in\\_Middle\\_School](http://www.researchgate.net/publication/357487070_Automating_the_Assessment_of_Algorithms_and_Programming_Concepts_in_App_Inventor_Projects_in_Middle_School).
65. Lang K. Become an app Inventor: the Official Guide from MIT App. Inventor; 2022. Available:[https://books.google.ro/books?id=4Y9xzgEACAAJ&dq=editions:KjXiTtYZ-fkC&hl=ro&sa=X&redir\\_esc=y](https://books.google.ro/books?id=4Y9xzgEACAAJ&dq=editions:KjXiTtYZ-fkC&hl=ro&sa=X&redir_esc=y).
66. Florea N, Bălăceanu V, Răuță C, Canarache A, Coordinators. Metodologia elaborării studiilor pedologice: partea a III-a – indicatorii ecopedologici, Institutul de Cercetări pentru Pedologie și Agrochimie, București; 1987.
67. Cioruța BV, Coman M. Can the MIT App Inventor® application be integrated into soil protection strategies?. Technium Sustainability. 2022;2(3):46-64.

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