

MoLE: A web authoring tool for building mobile learning experiences

Pedro A. Dal Bianco¹; Federico R. Mozzon Corporaal¹; Alejandra B. Lliteras^{1,2};
Julián Grigera^{1,2}; Silvia E. Gordillo^{1,2}

¹ UNLP, Facultad de Informática, LIFIA, Calle 50 &, Av. 120, La Plata, Buenos Aires

² CICPBA, Buenos Aires, Argentina

{pdalbianco, fmozzon, lliteras, jgrigera, gordillo}@lifia.info.unlp.edu.ar

Abstract. This paper presents a web authoring tool that allows teachers to build their own mobile learning experiences, so that their students can carry out a learning activity of the teachers authorship. In this work, a learning activity consists of a set of tasks organized through a workflow, which are given to students in relevant places (within a physical space). The workflow defines the way in which students access each of the tasks proposed in the activity. A preliminary case study and two technological implementations are presented. Although the present is a work in progress, it is based on previous works on the subject and proposes an evolution of them, incorporating technological and usability improvements both in the author's web tool and in the mobile learning application that it generates.

Keywords: authoring tool, mobile learning, mobile learning application, web tool, workflow, learning activity, physical interaction, digital interaction

1 Introduction

Mobile devices, especially smartphones, are heavily present in various activities of daily life. These do not only work as cell phones, but they are also powerful tools that integrate functionalities for which, many years ago, it was necessary to have different physical devices. For example, they integrate the possibility of taking photographs, recording audio, accessing online games, knowing the current geographical position and being connected through social networks.

The presence of these devices went through the walls of schools occupying a place in the classroom. It is very important for the teacher to capitalize on its use for educational activities, guiding the student to a safe and appropriate use of the educational context. Some proposals for its use in the classroom, for example, involve using search engines like Google or applications like the calculator to solve mathematical activities. In other cases, technology experts design and implement educational proposals mediated by mobile technology so that teachers can use them in the classroom, but without the teachers being able to participate in that process.

However, it should be possible for teachers to create their own mobile learning activities to be used by their students as part of the classroom activity, without requiring the assistance of technology experts. Different approaches to this problem are given by existing proposals [1], [2], which although they allow the creation of a whole mobile application, still require the teacher to have some knowledge about

concepts such as block-based programming, and aim to the user learning those skills and creating a generic application, rather than being used to design a learning activity.

Because of this, in this work, we highlight the need of providing teachers with tools that allow them, in an intuitive and independent way, to design, implement and carry out mobile learning experiences, to be used by their students through mobile devices. As this tool is aimed at users with little or no knowledge about application development, one of the first aspects to consider is the fact that it should be as intuitive as possible, so its usability will be a fundamental pillar at design time. This is one of the main points that differences this tool with other works in this same line, since the user has more freedom when developing an activity, this implies (as will be seen in Section 2) that he will have to learn certain programming concepts to be able to carry out the development of an application.

The present work aims at constituting an element of empowerment for teachers when designing and proposing their own solutions mediated by mobile technology.

This paper is structured as follows: Section 2 presents related works, then Section 3 describes the work that is adopted as the basis for the proposal introduced in Section 4. Section 5 presents the implementation of the proposed work and in Section 6, a first case study is presented where the web authoring tool is used to generate two technological implementations. Finally, in Section 7, the conclusions are presented and future works are proposed.

2 Related Work

Some similar tools already exist in the field. App Inventor [1], developed by MIT, allows users to generate their own mobile applications with the simplicity provided by block programming, allowing to use all the previously mentioned tools such as GPS, camera, storage and other functionalities provided by the mobile devices. Although it is precisely this freedom that users have when creating their tool which, as mentioned in [3], does not allow exploited all functionalities. Many users of this tool, however, cannot fully exploit its functionalities as they are not familiar with programming. As mentioned in [3], users do not use something that is not intuitive.

Vedils [2], is built on top of App Inventor, incorporating the integration of augmented reality and learning analytics features. This tool maintains most of the features of the aforementioned App Inventor [1], and therefore many of the problems already introduced at the beginning of this section. In [4] Vedils is studied in depth and a concrete case of use where is presented for teachers developed their own educational activities, but for this, the teachers first had to carry out workshops where they were offered knowledge about programming in blocks assisted by experts. In [5] there is another case of using Vedils for the creation of an educational tool, this time to assist in the teaching of a mathematics course, in this case, the tool was developed entirely by experts. The above suggests that Vedils does not allow people with no programming background to design and implement learning activities with mobile devices on their own.

Another relevant work is described in [6], where a web authoring tool is developed so that teachers in the area of mathematics can design learning activities based on

positioning, in which students must go through a series of locations on a map, guided by mobile devices. Although to design an educational activity using this tool does not require any specific knowledge in the area of programming, the tool aims exclusively to be used in the area of mathematics, and the locations on the map are only used to build a route, the student does not receive specific content in each of them.

3 Basis of the proposed work

We have previously presented a web authoring tool for configuring Android learning applications. Using it, a teacher defines a learning activity divided into tasks to be performed in relevant places within a physical space. In particular, this tool considers three tasks for collecting elements of the real world and one task for depositing them.

When the teacher creates the learning activity, they define the physical space where the activity will take place, between 2 and 3 criteria for depositing elements and 3 tasks for collecting elements. For each of these tasks, the teacher defines: i) a statement that the student will receive in their mobile device, ii) the elements of the physical world with which they can interact, indicating which are correct to collect to answer the statement and which are not, iii) to which criterion of the defined to deposit each element corresponds and iv) optionally, additional scaffolding material.

The above described defines a particular scheme of work. This implies a particular way to design and plan the activity, that is, the amount and type of tasks to be performed is predetermined, as well as the order in which the tasks should be performed. The collection tasks can only be carried out sequentially. The sequence is determined by the order of creation. The tasks that involve depositing elements can be accessed after performing any collection task. The above can be visualized in Fig. 1.

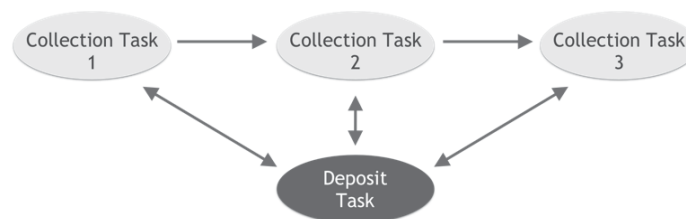


Fig. 1. Scheme of work

From the technological aspects, the mobile application is presented as an independent and configurable tool. The one that considers the positioning of the users through the use of QR codes doesn't require an internet connection or the use of GPS.

The configuration of the mobile application is done through a JSON file and a set of images of the physical space. These images are used to assist the user in their mobility. Fig. 2 shows the architecture of the solution presented in [7].

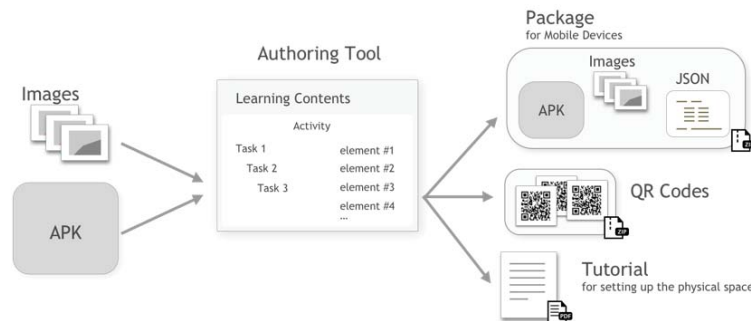


Fig. 2. Image (translated) extracted from [7] showing the architecture of solution presented.

Using this tool, the teacher can generate everything necessary for the configuration of the learning activity to be done with mobile devices, namely:

- The QR codes to identify each task, the elements of each task and the deposits defined for the activity.
- An instruction on how to configure the physical space where the activity will take place. In this instruction, each of the steps to be followed is detailed.
- Also, a folder containing:
 - The generic mobile application that must be installed on the mobile device
 - A JSON file that contains the configuration of the activity
 - A set of auxiliary images for the configuration of the activity

The tool presented in [7], however lacks the necessary flexibility for the teachers to implement their own ideas, since it doesn't allow creating tasks that are not for collecting or depositing elements, and that the only interaction considered is physical. Additionally, "Resuelvo Explorando" allows only access to a single configuration.

4 A Web Authoring Tool to Build Mobile Learning Experiences

Based on the need to have a flexible authoring tool that allows the teacher to create mobile learning experiences, we designed "MoLE". MoLE is a web authoring tool that allows teachers without knowledge about mobile development or programming to create their own learning activities mediated by mobile technology

The construction of mobile learning activities using MoLE follows the conceptual framework proposed in [8]. This means that the activity is defined in terms of the following aspects: the educational content (tasks), the physical space where it will take place, the identification of relevant places within that space, the structuring of the content (linear, free or graph) and finally indicating in which place of the physical space will be carried out each component of the chosen structure. Defining the activity in this way favors the possibility of reusing the aspects involved [8].

MoLE allows creating different types of tasks:

- **Multiple choice tasks**, where the person who performs the activity must choose the correct option from a set of options created by the teacher.
- **Open question tasks**, where a text should be written in answer to a question selected by the teacher.

- **Collection tasks**, where it should recollect real-world objects based on a criterion defined by the teacher.
- **Deposit tasks**, where deposit the elements recollected in the previous tasks in an appropriate deposit.
- **Tasks for the generation of content**, either through images, audio or video that respond to a given statement.

In addition to the described above, the possibility of extending the different types of tasks in the future is contemplated in a simple way in order to provide more flexibility to the teacher when it comes to diagramming the tasks.

The content is structured by a workflow. Each step indicates the task and the place within the physical space where it will be provided. Finally, the teacher sets the order. For this, they can choose between predetermined workflows: sequential (lineal), without pre-established order (free or set), or customized (graph). In addition, each activity designed by the teacher can be reused on any mobile device that has the application for mobile devices.

The type of each task can be multiple choice question, single-choice question, open question, image captures, video or sounds according to a slogan, collection or deposit of pre-established elements as part of the task.

The concept of workflow has been implemented considering some of the aspects described in [9] and [10] where different types of workflows are seen and how each one can be convenient for different activities and for different user experiences. According to the authors, an important aspect when designing a workflow is that the users, in this case the teachers, get constant feedback of what they are doing.

5 MoLE Implementation

The implementation of MoLE consists of three components that interact with each other: a web authoring tool, a REST API and a mobile learning application. Below is a brief description of each one.

5.1 Web authoring tool

This tool guides the teacher in the creation of location-based learning activities. Each activity can be composed by tasks of different types. Each task can be done in a relevant place in the physical space. The tool proposes stages of creation following the conceptual framework proposed in [8] and implements the activities approach presented in [11]. The front-end of this tool was developed using the libraries ReactJS¹ and Redux², and for the backend it connects with an API (see Section 5.2).

¹ <https://reactjs.org>

² <https://redux.js.org>

5.2 REST API

This component provides an interface to a database designed with MongoDB³ through methods to save the generated activities and then retrieve them and be able to consult information about them. This mechanism offers the possibility of retrieving information from both the web tool (described in Section 5.1) and the mobile learning application (described in Section 5.3) and if a new type of device is added eventually, do so through these same methods.

This API was implemented using NodeJS⁴ and Express⁵ library.

5.3 Mobile learning application

The mobile learning application downloads the activities from the API described in Section 5.2, allowing in one hand to have multiple activities in the mobile application and in other hand, to execute each one, independently of each other, repeatedly. This application was implemented considering the aspects of usability and the lessons learned in [12]. React Native⁶ was used for its development, which allowed to have a native and multiplatform application. This application is available for any mobile device with an Android version greater than 5.0, or a version of IOs greater than 10.0. Fig. 3 shows the architecture of the implementation.

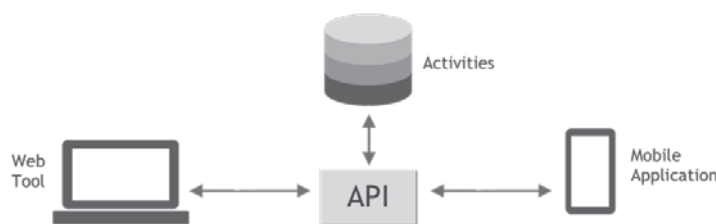


Fig. 3. Architecture of the proposed implementation

6 Case Study

In this section we present a case study to use the proposed web tool to obtain a functional mobile application. In the first place, the learning activity is described from the conceptual perspective and then, two possible forms of implementation are presented, on the one hand involving physical interaction with elements of the real-world and on the other, with digital elements (digital interaction).

³ <https://www.mongodb.com>

⁴ <https://nodejs.org>

⁵ <https://expressjs.com>

⁶ <http://www.reactnative.com>

6.1 Conceptual learning activity

Following the conceptual framework proposed in [8], a learning activity was designed to raise awareness regarding the recycling of Waste Electrical and Electronic Equipment (WEEE).

In the first place, a multidisciplinary team was formed with members of the “E-Basura” program of the UNLP⁷, members of the Environmental Awareness Board of the Informatics School of the UNLP and some of the authors of this work. Then, the learning activity was conceptually designed. For this, three tasks were defined whose statements reflected the need for the participant to identify WEEE elements according to the use that could be given to them, and then determine if said element could be delivered to the user.

This activity was designed to be carried out after members of the “E-Basura” program presented the necessary concepts to the participants, in order to know which of them were not acquired by the participants and reinforce them

In a next instance, aspects related to the interaction that the participant was expected to have with the WEEE elements (that were a priori conceptual) were determined. From this, two technological implementations were proposed, one that involved elements of the real-world, so that the participant could manipulate by means of a physical interaction and, on the other hand, one based on digital elements through digital interaction. Each of them is described below.

6.1.1 Implementation considering physical interaction

The implementation is based on the fact that the participants could see and "touch" (manipulate) electrical and electronic equipment, which was considered important so that these could later recognize in their usual spaces (e.g. study, work, housing), elements that could be taken to the recycling center of the “E-Basura” program.

In this implementation of the case study, to carry out the physical interaction, three tasks of the type of collection and two of the deposit types (both types described in section 4) were instantiated. A collection or deposit criteria was specified for each one, and then a series of elements was defined, that correspond to the elements of the real-world, indicating the criteria under which they had to be deposited or collected. We used different electrical and electronic elements and statements related to their utility.

From the perspective of the web tool proposed in this work, it was necessary to create the leaning activity, the tasks and set up the workflow with the tasks and indicate where each of the tasks of the workflow will be carried out. Upon completion of the creation from the web authoring tool, the user has the following files:

- A configuration file indicating how to configure the physical space.
- A file with QRs identifying the tasks.
- A file with QRs that identify each element of each task.
- A code to download from the mobile application the configuration (activity) created from the tool for the WEEE domain.

⁷ <https://e-basura.unlp.edu.ar>

To use the mobile application, users must:

- Configure the physical space of use, locating the corresponding QR codes to the tasks according to the configuration file of the space.
- Place each corresponding QR element.
- Physically arrange each element with your QR, in the relevant place of your task.
- Access to the download code from each device, to make available the configuration for WEEE.

Fig. 4 shows WEEE elements used for the three collecting tasks.



Fig. 4. WEEE elements used for the three collecting tasks

Next, Fig. 5 shows the statements of the three tasks that involve collecting elements for the use that can be given and that it implies physical interaction, since the real-world elements must be manipulated and its QR read from the mobile device.

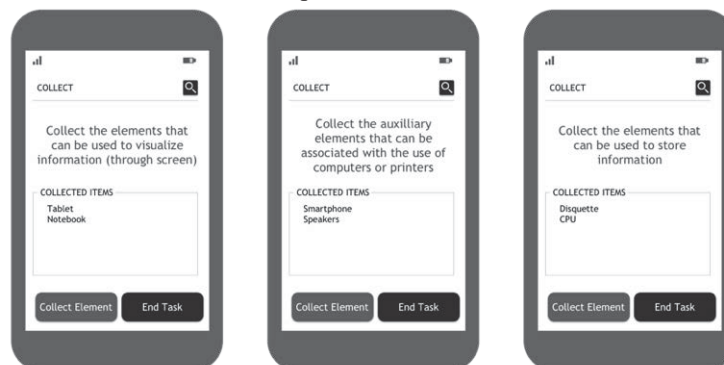


Fig. 5. Visualization of the statements to collect WEEE elements with physical interaction

6.1.2 Implementation considering digital interaction

In this implementation, the end user does not have to manipulate WEEE elements from the real-world or use the QR reader to collect them. For each setpoint of a task that it receives in a certain place (by reading a task QR), in its device it visualizes a list with the names of the elements of the task and it will have to select each one that consider correct by touching the screen.

From the perspective of the tool proposed in this work to create digital interaction, it was necessary to create the learning activity, the tasks and the workflow. This does not vary from the implementation made to be used with physical interaction.

After the creation from the web authoring tool, the user obtains the following files:

- A configuration file indicating how to configure the physical space.
- A file with QRs identifying the tasks.
- A code to download from the mobile application the configuration (activity) created from the web tool for the WEEE domain

To use the mobile application, users must:

- Configure the physical space of use, locating the QR codes corresponding to the tasks according to the configuration file of the space
- Access the downloaded code from each device to make available the configuration for WEEE

Fig. 6, shows the statements of the three tasks considering digital interaction.

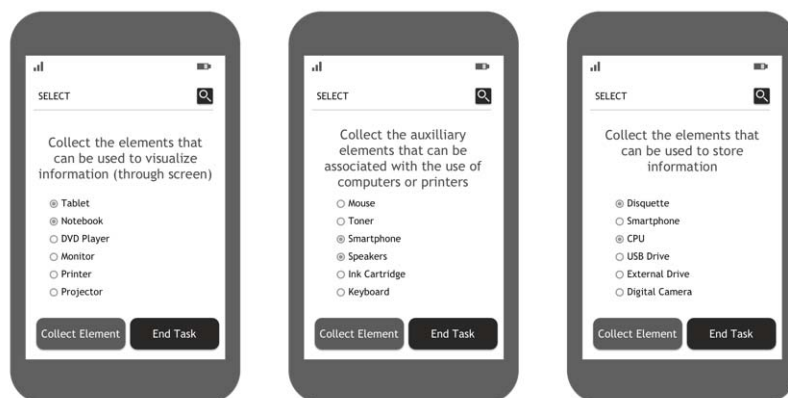


Fig. 6. Visualization of the statements to select WEEE elements with digital interaction

7 Conclusions and Future Work

This article presented the work in progress of a web authoring tool for the construction of mobile learning experiences that consider the position of the student to provide tasks consistent with it. Given that the development is at an early stage, there have not yet been tests with end users that allows us to compare the students' preference for both types of interaction implemented. It is expected that this tool will give the teacher the possibility of including technology in the class through activities of his authorship carried out on mobile devices, in an intuitive way and without the need to have knowledge about application development.

As future work we plan to complete the development of the tool presented in order to be evaluated by end users, considering aspects of learnability and usability of both the tool and the resulting mobile application. We also plan to work in the management of a community of teachers who use this tool to design their own learning activities, in order to get real feedback regarding the tool's functionality and usefulness. Another proposal consists in using the modeling approach that implements our tool and the lessons learned to perform activities that involve data or samples collection (e.g. images, audio, video, guided observations) to be used in Citizen Science projects.

Acknowledgments

The authors would like to thank Patricia Bazán director of "Recicla tu Compu-Recicla tu Mundo" project of the "Facultad de Informática , UNLP, Viviana Ambrosi director to "E-Basura" program of de UNLP, and Edgar Vega member of this program for their contribution on the configuration using the proposed tool.

References

1. App Inventor, <http://appinventor.mit.edu>
2. Vedils, <http://vedils.uca.es>
3. Xie,B., Shabir,I., Abelson, H.: Measuring the usability and capability of App inventor to create mobile Applications. In: 3rd International Workshop on Programming for Mobile and Touch (PROMOTO 2015), pp. 1--8. ACM, New York, NY, USA, (2015). DOI=<http://dx.doi.org/10.1145/2824823.2824824>
4. Mota., J.M., Ruiz-Rube, J., Dodero, J.M., Arnedillo-Sánchez, J.: Augmented reality mobile app development for all. *Computers & Electrical Engineering*. 65, 250--260 (2018). DOI: 10.1016/j.compeleceng.2017.08.025.
5. Person,T., Mota, J.M., Listán, M.C., Ruiz-Rube, I., Dodero, J.M., Rambla Barreno,F., Patino, C.M., Serván, A.R., Vidal Pérez, J.M.: Authoring of educational mobile apps for the mathematics-learning analysis. In: Sixth International Conference on Technological Ecosystems for Enhancing Multiculturality (TEEM'18), Francisco José García-Peñalvo (Ed.). pp. 299--305 ACM, New York, NY, USA. (2018). DOI: 10.1145/3284179.3284234
6. Sollervall, H., Gil de la Iglesia, D., Zbick, J.: Supporting Teachers' Orchestration of Mobile Learning Activities. *Mathematics Education in the Digital Era*, 91--111. (2018). DOI:10.1007/978-3-319-90179-4_6
7. Mozzon Corporaal., F.R., Dal Bianco, P.A., Lliteras, A.B., Grigera, J., Gordillo, S.E.: Una herramienta de autor web para generar aplicaciones educativas basadas en posicionamiento con interacción física. XXIV Congreso Argentino de Ciencias de la Computación. 253-262. ISBN: 978-950-658-472-6. (2018).
8. Lliteras, A.B., Challiol, C., Gordillo, S.E.: Location-based mobile learning applications: A conceptual framework for co-design," Twelfth Latin American Conference on Learning Technologies (LACLO), La Plata, pp. 1-8. (2017) DOI: 10.1109/LACLO.2017.8120946
9. Sprinks, J., Wardlaw, J., Houghton, R., Bamford, S., & Morley, J.: Task Workflow Design and its impact on performance and volunteers' subjective preference in Virtual Citizen Science. *International Journal of Human-Computer Studies*, 104, 50--63 (2017) DOI: 10.1016/j.ijhcs.2017.03.003
10. Crowston, K., Kitchell, E.M., Østerlund, C.: Coordinating Advanced Crowd Work: Extending Citizen Science. In: 51st Hawaii International Conference on System Sciences. Vol. 4, no. 1, pp. 1681--1690. (2018). DOI: 10.24251/HICSS.2018.212
11. Lliteras, A.B., Gordillo, S.E., DalBianco, P.A., Mozzon, F.R.: A customizable location-based Mobile Learning Prototype: A case of study, XIII Latin American Conference on Learning Technologies (LACLO), in press, (2018)
12. Lliteras, A.B., Grigera, J., Dal Bianco, P.A., Mozzon Corporaal, F.R., Gordillo, S.E.: Challenges in the design of a customized location-based mobile learning application. XIII Latin American Conference on Learning Technologies (LACLO), in press, (2018).