Formation et profession
Revue scientifique internationale en éducation

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Volume 30, numéro 3, 2022

La formation par compétence : ses enjeux, ses défis, son avenir

URI : https://id.erudit.org/iderudit/1099374ar
DOI : https://doi.org/10.18162/fp.2022.645

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Éditeur(s)

Centre de recherche interuniversitaire sur la formation et la profession enseignante (CRIFPE)

ISSN

1718-8237 (imprimé)
2368-9226 (numérique)

Découvrir la revue

Citer cet article

Meyer, F. & Théau, J. (2022). Stand-alone Field Trips Based on Geolocation as a Meaningful Source of Learning for Geomatics Students. *Formation et profession*, *30*(3), 1–17. https://doi.org/10.18162/fp.2022.645

Résumé de l'article

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Stand-alone Field Trips Based on Geolocation as a Meaningful Source of Learning for Geomatics Students

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doi: 10.18162/fp.2022.645

Abstract

The project presented is a prototype of self-guided field trips that rely on the use of a mobile device (tablet) and several of its functions. The article discusses the second iteration of a design-led research approach. The design and research issues were mainly centered on the acceptance of the application and its multiple parameters by the teachers, and on the acceptance by the students of its use for learning purposes. An existing application (TaleBlazer) was selected and adapted. Observed acceptance was measured using the UTAUT model combined with qualitative feedback.

Keywords

Geolocation, Stand-alone field trip, Design-based research, Mobile application.

Résumé

Le projet présenté est un prototype de sorties terrain autoguidées exploitant un appareil mobile (tablette) et plusieurs de ses fonctions. L'article traite de la deuxième itération d'une démarche de recherche orientée par la conception. Les enjeux de la conception et de la recherche étaient principalement centrés sur l'acceptation de l'application et de ses multiples paramètres par les enseignants et sur l'acceptation par les étudiants de son utilisation à des fins d'apprentissage. Une application existante (TaleBlazer) a été sélectionnée et adaptée. L'acceptation observée a été mesurée à l'aide du modèle UTAUT combiné à des commentaires qualitatifs.

Mots-clés

Géolocalisation, sorties terrain autoguidées, recherche orientée par la conception, application mobile.

Since 2010, the Université de Sherbrooke, Québec, Canada, has been offering a master's degree program in geomatics that is taught through video-conferencing simultaneously between two campuses. The main goal of this program is to enable students to develop skills and competencies in analysing and understanding of territories in their spatial dimensions. In this program, field trips represent a necessary activity for students in order to construct meaningful and contextualized learnings, and to illustrate various concepts seen in class in a real-world setting. This context of hybrid education has its set of challenges, especially for teachers when it comes to organizing group field trips and the activities that they require.

The innovation project presented in this paper, emerges from this specific context. Its purpose is to develop an application prototype that allows students to engage in self-guided field trips using a mobile device (mainly android electronic tablets). This is done by using various functions available on this type of devices: screen visualization, GPS, picture taking etc. The scientific aims of this project were defined while designing the prototypes, and they focus on the acceptance and the use of such an application by university professors and their students.

In order to implement this innovation, we based our development process on a systematic Design-based research (DBR) approach (Sanchez & Monod-Ansaldi, 2015, Wang & Hannafin, 2005). DBR is characterized by its flexibility and its iterative nature, which makes it suitable for the development of pedagogical innovations such as the one presented in this paper. During the first iteration of the project, an initial prototype was developed and tested with small groups of students who took part in a field trip at the Mont-Orford National Park (QC, Canada). The second iteration took place the following year and led to the implementation of a different prototype. Several field trips have thus been conducted, as part of different courses of

ISSN 2368-9226

the geomatics program, in order to integrate and test this new prototype. We are currently working on the third iteration.

This paper focuses on the second iteration and explores some use-cases of digital technologies for the enhancement of teaching and learning practices, as encouraged by the Digital Action Plan for Education and Higher Education[1]. In order to facilitate the reading, we decided to always present the pedagogical dimension and the research dimension in parallel, since both are highly intertwined. Please note that the chronological order of the development process is not necessarily followed. First, the pedagogical and research problems are presented; second, the conceptual frameworks used for the pedagogical and technological design, and for the research questions are developed; third, the design-based research approach which characterized this project is presented; fourth, the main results are presented which includes the pedagogical design and the data collected thanks to questionnaires. This article then ends with a discussion of the results of this experimentation, followed by a discussion of the next iteration phase which will be of high importance, since the COVID-19 crisis has led our university leaders to strongly recommend the implementation of hybrid learning solutions in every program.

Pedagogical and research problem

The master's degree program in geomatics at the Université de Sherbrooke is offered in a hybrid mode (Meyer & Sanchez, 2016) by the Department of Applied Geomatics. It is a professional program during which students are expected to develop skills and competencies that require an understanding of territories and their spatial dimensions (Théau, Giguère & Gagnon, 2014). The professors involved in this program consider field trips to be a significant activity, because they allow for the contextualization of the theoretical notions that are taught during classes, in the form of in situ, concrete experiences. In order to integrate this type of activity into a hybrid program, Théau and his colleagues initiated a project aimed at facilitating the use of mobile devices for the guidance of students during self-guided field trips through the use of a dedicated application and geomedias. The purpose of the application is to offer an interface to teachers to enable them to create different field trip scenarios according to their courses' pedagogical objectives. The application also offers an interface to students so that they can access what was created for them by the teacher. Students can experience these field trips on their own with the sole support of the dedicated application.

Geomedias, or geo-referenced media technologies, are an essential tool for the training of geomatics students (Jekel, Sanchez, Gryl, Juneau-Sion & Lyon, 2014). In this field of study, teachers try to promote active involvement through information seeking and analysis (Čerba, Charvát, Jedlička, Šilhavý & Janečka, 2012). Geomedias enable students to support their situational analysis through concrete geographic resources (Jekel et al., 2014). The purpose of using geomedias, is to enrich the quality of learning by contextualizing and increasing interactions (Charlier, De Schryver, & Peraya, 2006).

The interest of teachers and students towards field trips is not a recent occurence. Several studies have already demonstrated the educational value of these activities on the learning process (Falk & Dierking, 1997). The notion of serious games (Sanchez, Ney & Labat, 2011) offers support for the achievement of the goal of combining geomedias and field trips. According to these researchers, serious games lead students to become self-reliant in their problem-solving approach, while also providing them with a situated learning experience (Donaldson, Fore, Filippelli & Hess, 2020; Shaffer, Squire, Halverson & Gee, 2005). Donaldson and his colleagues (2005) obervered that in geoscience education, situated learning theory is often mobilized and "offers a means for enabling students to connect their learnings to the real-world by situating (as the name states) experiences in authentic learning contexts" (p. 723).

The assessment of the first iteration of this work led to two avenues of reflections: pedagogical and technological. These reflections were then the starting point of the second iteration. At the pedagogical level, all students considered the self-guided field-trip to be useful, as it allowed them to observe theoretical elements seen in class in the field. At the technical level, overall, the application was highly appreciated and the ease of its use was also noted as a key factor of this appreciation. However, students highlighted certain limitations related to the use of tablets in the field. They experienced difficulties due to the low brightness of the displays in sunny conditions, and were concerned about the fragility and handling of this type of equipment in rough field conditions. In comparison with other types of field-trips (i.e. guided or conventional), opinions were mixed. Half of the students were more supportive of conventional methods, while the other half found this technology useful. These observations made during the first iteration allowed us to confirm the pedagogical potential of this type of application, and to identify the problems to be solved as well as the questions to be addressed during the second iteration.

One often assumes that students are fond of technology. However, the first iteration demonstrated that there still exists reluctance regarding the use of this kind of tools. Supporting the acceptance and use of technology (Lakhal, Khechine et Pascot, 2013) by students, as well as by teachers, was therefore a key element to focus on during the second iteration. It also highlighted the need to both provide support for the use of this equipment and to select ergonomic and user-friendly equipment in the first place. Second, the development of the first application prototype was done in a very short amount of time. The result were satisfactory but deserved a greater integration, for instance by allowing teachers to generate their own stand-alone field-trips via a user-friendly interface. Since we are aiming to develop an application used by different teachers in different courses and even different disciplines, this aspect was the second key element to be considered in the second iteration. Finally, the creation of a field-trip using this type of application proved to be demanding in terms of educational scripting. It allowed us to gain awareness of the importance of developing tools to guide teacher when building their field-trips. Standardization and development of systematic steps were, therefore, the third element to focus on during this second iteration.

During the first iteration, the research was limited. The only element that was actually measured with a questionnaire was the satisfaction of the students who had had a chance to experiment the application. We also collected some qualitative data in the form of comments relative to their satisfaction. It was then important to further deepen our research to better understand the effect of this kind of application. A review of existing applications highlighted the fact that this kind of application was neither available nor used at that time (Jarvis, Tate, Dickie & Brown, 2016; Tan, Zhang & McGreal, 2011) and that, as a result, not much was known about their acceptance and use in a higher education context.

In summary, the research goal of this second iteration was to understand if the design was appropriate relative to the students' and teachers' needs. Thus, measuring the acceptance and the use of the designed prototype by the students, as well as by the teachers, was an important element that we focused on during this second iteration.

Pedagogical framework

Field-trips are activities that allow for a contextualization of the theoretical notions seen in class thanks to concrete, in situ experiences. These experiences represent a key component of situated learning theories (Donaldson, Fore, Filippelli & Hess, 2020) as they facilitate an active engagement through information seeking and analysis (Čerba et al., 2012). With this in mind, the design of the application, and its accompanying resources, was based on three important concepts: active learning, serious games and digital literacy.

Since the targeted competencies of the courses in which the application was going to be experimented with require active engagement on the learners' end, active teaching methods are central to the potential uses of the developed application. It is also essential to ensure that learning and evaluation activities are aligned, and are in support of the learning goals (Biggs, 2003). It is also important to make sure that the technological features of the application support and reinforce the efficiency of these activities (Lebrun, 2007).

Yost Hammer & Giordano (2012) define active learning as "a student-centred model of teaching and learning, in which teachers ignite student thought, reflection, application, and curiosity. Students are not merely passive listeners, but instead, active problem solvers who begin to see themselves and their peers as sources of knowledge" (p. 100). The intent here was to ensure that the application would enable learners to be cognitively engaged when came time to collaborate, to produce, to build and to be in charge of their own learning.

Romero, Dumont, Daniel, Barma, Ferrer & Hénaire (2016) explain that digital game-based learning (DGBL) engages the learner in interactions with digital artifacts that support the action of playing and develop learning objectives. The authors distinguish four main types of serious games use. This project can be defined as an educational game with a specific educational purpose: supporting geomatics students in the development of professional competencies.

Games reinforce the commitment and the motivation of learners while also enabling them to engage in authentic activities (Sanchez, Ney & Labat, 2011) where complex tasks can be accomplished. These tasks mobilize procedural and declarative knowledge, by requiring the implementation of original strategies that the learners themselves have to come up with. Those tasks are contextualized and require negotiations with other learners. These aspects are perfectly consistent with our desire to promote active methods of learning. Sanchez and his fellow researchers underline that "the playful approach offers, in the range of active pedagogies, a privileged way to involve the learners, in particular by immersion in a realistic universe" (Sanchez, Ney & Labat, 2011, p. 51). These elements contributed to our consideration of an application for field-trips as a playful means (inspired for example by treasure hunts) to give more richness and relevance to active teaching methods.

The digital literacy of the students was considered to be a key factor to guarantee the quality and satisfaction during the experimentation of the application during field trips activities. Therefore, it was essential to offer resources to make students more and more autonomous in the reading, writing, researching and organizing of digital information (Fastrez & De Smedt, 2012) with the help of the application. We also carefully considered the complexity of teaching knowledge. Teachers, in order to effectively and efficiently handle such an application, must appeal to technological, pedagogical and disciplinary knowledge. The TPaCK model (Koehler & Mishra, 2009) particularly helped us in the resources construction process, but also in the definition of the stages meant to accompany the users during the elaboration of field-trips.

Research framework

The purpose of this research was for us to understand the experience of each person who used the application and its resources. In this context, it is important to consider that reality does not exist independently of individuals and their construction of said reality (Charlier, 1998). The actors to consider in this research are, therefore, the users themselves (professors and students), because they are the only ones able to relate their experiences with the implemented processes.

The application promotes a real redefinition of field-trips and serves the role of completely new technology in these activities. It, therefore, seemed rather wise, at this stage, to first grasp the acceptance of this technology as well as the appropriation strategies implemented by the participants. In order to understand acceptance, we refer to the UTAUT Model (Unified Theory of Acceptance and Use of Technology) developed by Venkatesh, Morris, Davis & Davis (2003) and adapted and integrated by Lakhal, Khechine & Pascot (2013). Many reasons led us to use this model. Apart from the fact that it is simple, concrete and validated, it very well targets the questions that arise, while making it possible to measure the degree of acceptance of a new technology implemented in a specific context. This model is based on several other models, hence the fact that it is referred to as a "unified" model. It is composed of five main categories:

[#] PE (Performance Expectancy): the degree of belief a person has that using a system will help them achieve a higher level of academic performance.

EE (Effort Expectancy): the degree of ease perceived by a person relative to the use of the system.

SI (Social Influence): Does a person perceive that influential people around them believe that they should use this system?

FC (Facilitating Conditions): degree of belief of a person that there exists an organizational and technical structure to support the use of the system.

BI (Behavioral Intentions): intention of a person to use this system in their future personal or professional activities.

Design-based research approach

As far as the pedagogical design itself is concerned, we used a rigorous pedagogical design method called MISA (Paquette, 2002) (which stands for *Méthode d'Ingénierie des Systèmes d'Apprentissage* in french (Nizet & Meyer, 2014)), to guide us through the different phases of the cycle (i.e. analysis, design, implementation, action and evaluation).

This entire iterative process took place over a period of almost two years. The design team consisted of a geomatics professor, a professor specializing in educational technologies in higher education and a master's degree student in geomatics who served as an assistant.

In addition to this team, four geomatics teachers from the master's program intervened at various stages of the project. As a first step, we precisely identified the needs and expectations of future users. These four stakeholders contributed to this identification process by sharing their expectations and needs, and by validating the created user stories. 24 user stories were generated for the teachers, and 12 for the learners. Here is an example of a user story for a teacher : "*I want to define, for each step, the data that the students will have to collect during the field-trip*". Now here is an example of a user story for a student : "*I want the instructions and tasks to be activated though the use of GPS when I arrive at a specific location during the field trip*".

After identifying these needs, we conducted a review of existing tools and applications that allow for the creation of field-trips or treasure hunts, to see if we needed to develop our own application, or if we could invest in a pre-existing solution. This step was decisive because it would have had a significant impact on further developments, given the budget available to us. We benchmarked 12 different applications and selected TaleBlazer because it was the solution that met the most criteria as shown in Table 1.

Table 1
Review of applications according to selective criteria

	1	2	3	4	5	6	7	8	9	10	11	12
Application	Tale Blazer	Aris	Fresh Air	White point	Tour-On	Sca vify	History pin	iTreasure	Viewranger	Fieldtrip GB	a: Drake	Furet Comp.
Open Source	No	Yes	No	No	No	No	No	No	No	Yes	No	No
Android	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Free	Yes	Yes	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
GPS	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Updates	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Steps	Yes	Yes	Yes	No	Yes	Yes	No	Yes	No	n/a	n/a	Yes
Coordinates per step	Yes	Yes	Yes	No	Yes	Yes	No	Yes	No	n/a	n/a	Yes
Texte Insertion	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	n/a	Yes	Yes
Picture Insertion	Yes	Yes	Yes	Yes	Yes	n/a	Yes	Yes	No	n/a	n/a	Yes
Stock maps	Yes	Yes	Yes	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
Offline Mode	Yes	No	Yes	Yes	n/a	n/a	n/a	n/a	Yes	Yes	Yes	Yes
Protection	Yes	No	Yes	n/a	No	Yes	No	Yes	No	n/a	n/a	n/a
Total	11	9	10	5	8	8	6	10	6	7	7	9

Once this choice was made, we were able to focus on the design of pedagogical resources and the configuration of the application, in order to make it usable for the teachers and their students. Once this was done, the four collaborating teachers were accompanied in the design of their field-trip activities and the mediatization of these activities in the application. Finally, they went out and experienced their newly created field-trips with their students. Four different field-trips have been created and for each of them, 10 to 15 students took part in the activity (only a few students took part in more than one field-trip).

Once all the students had finished the different field-trips, we asked the participants (students and their teachers) to fill up a questionnaire about their experience and the technology that they had to use. This questionnaire was based on the UTAUT model (Venkatesh, Morris, Davis & Davis, 2003) and each dimension was composed of different items validated by Lakhal, Khechine & Pascot (2013). Each item was placed on a Likert scale of 7 levels varying from « strongly disagree » to « strongly agree ». There were also some open field questions where the participants were asked to identify and write down 3 positive aspects, 3 elements that can be improved upon, as well as suggestions. 4 teachers and 24 students filled the questionnaire following the experiment. For the analysis, Cronbach's alpha was calculated in order to check the internal consistency of the data. Then a descriptive analysis was made, linking elements emerging according to the UTAUT Model and qualitative comments made by the participants. It should be noted here that the number of participants was rather small, so the strength and scope of the statistical analyses are limited. The results obtained show trends but can in no way be considered statistically significant. Nevertheless, they offer interesting and relevant insights for this project and open up avenues for future research to consider.

The design-based research that we implemented in this project produced different data at each step of the process (Lafond-Touikan, Meyer & Théau, 2015). In this paper, we specifically want to present the data collected during the last step of our protocol and its interpretation, as well as the results produced by the activities organized by collaborating teachers.

Results

Pedagogical and technological design

In this iteration, the design method led us to the implementation of a prototype that uses the application called TaleBlazer (http://www.taleblazer.org/), which is an augmented-reality game creation platform developed by the Scheller Teacher Education Program's Lab[2] (Figure 1).

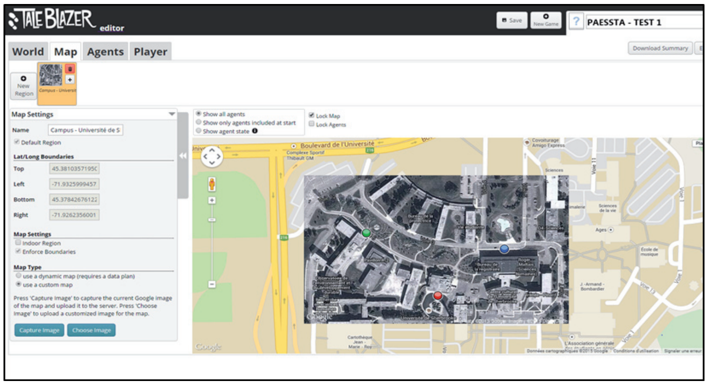

Figure 1
Creation of a field trip

Four field trips were created, integrated and tested with the help of this new prototype. The four field trips that were developed and experimented with are very different from, but coherent with our pedagogical framework. A description is provided in Table 2 and an example can be found in Figure 2.

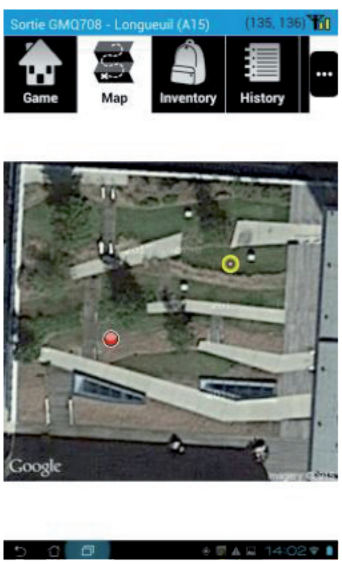

Figure 2
Student's view of a field trip

Table 2
Description and characteristics of the field trips

Course name	GMQ708 Optical and radar remote sensing	GMQ712 Geopositioning and mapping	GAE700 Ecotourism, parks, resources and geomatics	GMQ720 Air photo interpretation
Field trip content	Field measurements using specialised equipment for the validation of image processing done in class.	Cartographic data acquisitions in the field and integration in a collaborative map project (e.g. Open Street Map).	Identification of suitable sites for ecotourism using bio-geophysical data in the field.	Field validation of observations made in class using photo-interpretation.
Field trip configuration	Team field trip. No route assigned. Five stages to be selected by student. Text and video instructions provided. Assignments using notes and photos as well as using additional equipment (spectroradiometer).	Individual field trip. One route assigned for each campus. Preselected route with six specific stages. Text and video instructions provided. Assignments using additional equipment (GPS).	Individual field trip. One route for all students. Preselected route with five specific stages. Text, photo, map and video instructions provided. Assignments using tables, notes, and photos.	Team field trip. One route for all students. Preselected route with four specific stages. The fifth stage to be selected by students. Text instructions provided. Assignments using notes and photos
Contribution of the field trip to the course	Allows several teams to acquire data in the field simultaneously with minimal supervision.	Allows students to learn how to use a GPS, to observe positioning limitations, and to contribute to a collaborative map.	Allows students to go in the field and observe GIS data limitations as well as data acquisition challenges.	Allows student to plan a field trip and to observe limitations of photo- interpretation validation in the field.

Research Results

The questionnaire that was filled out by the students gives us strong indications regarding their acceptance towards the use of the particular technology that is the chosen and configured application. The following figures show the results for each dimension of the UTAUT model, on a course-by-course basis. Note that the coefficient of reliability (alpha) is strong for the "performance expectancy", "social influence" and "effort expectancy" dimensions. Also note that only a total of 24 students replied (10 students for GM708, 5 for GMQ 712, 5 for GAE 700 and 4 for GMQ720). These results are therefore reliable, but the small number of respondents does not allow for the observation of significant trends. Thus, it is important to consider these results as indicative trends.

Performance expectancy is the degree of belief that students possess, that the system will help them achieve a higher level of academic performance. On average, students graded this dimension to the tune of 4.5/7, which is slightly higher than the neutral level (Figure 3). In other words, students see some light potential in this application, when it comes to supporting them in achieving a higher level of performance. The course that received the lowest grade is GMQ712 (3.8) and the one that received the highest grade is GAE700 (5.2).

Table 3
UTAUT results for each course

	GMQ708	GMQ712	GAE700	GMQ720	Mean	Alpha
Performance expectancy	4.4/7	3.8/7	6.2/7	4.5/7	4.5/7	0.96
Effort expectancy	5.8/7	6/7	5.9/7	4.9/7	5.7/7	0.88
Social Influence	4.4/7	3.2/7	3.9/7	4/7	3.9/7	0.82
Facilitating conditions – Necessary knowledge	6.2/7	6.2/7	6.2/7	6/7	6.2	0.61

Effort expectancy is the degree of ease that one perceives while using the system. On average, students gave this dimension a 5.7/7 grade, which is much higher than the neutral level. In other words, students perceive this application as quite easy to use. The course that received the lowest grade is GMQ720 (4.9) and the one that received the highest grade is GMQ 712 (6).
Social influence translates in the case of the students by the perception that influential people around them believe that they should use this system. On average, students gave this dimension a 3.9/7 grade, which is very close to the neutral level. In other words, students seem to think that influential people around them don't really believe this application to be relevant. The course that was graded the lowest is GMQ712 (3.2) and the one that received the highest grade is GMQ708 (4.4).

As far as the "facilitating conditions" dimension is concerned, the coefficient is not strong enough for a firm interpretation of the results, however, there was one item in this dimension that caught our attention, namely "I have the necessary knowledge to use the application". Even though Cronbach's alpha isn't strong enough, we can still observe that the students felt quite at ease with the application and felt they knew enough to properly use it.

The other elements of the UTAUT model are not mentioned here, as their Cronbach's alpha is too weak, thus making these results non-significant. Nevertheless, the following two other complementary elements present in the questionnaire are still worth mentioning, even though they can't be considered as significant: "The tablet was appropriate for field trips" and "General appreciation of the field trip" (See Table 4).

Concerning the tablet's adequacy as a tool, on average, students gave this dimension a 5.5/7 grade, which is higher than the neutral level. In other words, students tend to believe that tablets are relevant for field trips. The course that received the lowest grade is GMQ712 (4.8) and the ones that received the highest grade are GMQ720 and GAE700 (5.8).

Another interesting result can be observed while discussing the appreciation of the field trips. On average, students gave this dimension a 5.3/7 grade, which is also higher than the neutral level. In other words, students appreciated these field trips. It is however interesting to observe the important grade difference between the course that received the lowest grade: GMQ712 (4.4) and the course that received the highest grade: GAE700 (6.4).

Table 4

Perception of adequacy and appreciation

	GMQ708	GMQ712	GAE700	GMQ720	Mean
Adequacy of the tablet in a field trip	5.6/7	4.8/7	5.8/7	5.8/7	5.5
Global appreciation of the field trip	5.1/7	4.4/7	6.4/7	5.4/7	5.3/7

Some qualitative comments emerging from the questionnaires are worth underlining. Some students made comments about the application itself and identified limitations that are mostly circumstantial: "The sound of the videos wad weak", "The lighting was too dim outside (difficulty seeing the screen)", "it was hard to go backward and reach the previous activities", "it would have been useful to have been able to take notes in the application", "videos and photos couldn't be downloaded"... Several possible improvements were also suggested in order to enhance the quality of the experience and the acceptance of the application. For example: "Having the ability to upload photos would be convenient. We could thus synthesize more quickly"; "I would have liked the option of an advanced interface in order to interact with the application to record a maximum of location-based data points..."; "Please integrate interactive maps"...

Some comments were related to the pedagogical dimension. Most were specific to each course, but some were more generic and thus more usable in our case. For example: "Do not organize this trip in late November / early December. September and October are much more appropriate weather-wise and student workload-wise"; "Please provide more information on how to use the GPS function within the application"; "Allow group field-trips"; "It would be nice to have the capability to separate important videos from secondary videos"; "It would interesting to have elements that allow for a better understanding of the immediate environment nearby"; "Please add more data about our preliminary analysis"...

Regarding the results as far as teachers are concerned, no statistics can be presented here since only 4 of those provided answers. Nevertheless, they made some qualitative comments that are worth noting. As a whole, teachers see an interesting potential in the use of tablets in the context of field-trips. They, for instance, commented on the work of our team as well as on the utility of the application: "It worked very well on the first try. Congratulations to the team!"; "A more user-friendly and fun approach, while enabling student's in their learning process"; "The application on an electronic tablet made it possible to gather on the same medium the location of the observation points, as well as the reference documentation that was useful for this stage of the process."

On the other hand, they identified software and circumstantial limitations similar to those that were raised by the students. Other areas of improvement are proposed as such: "There are some limitations related to the climate (too much sun, precipitation, cold etc.)"; "In the context of the course, it may not be the most appropriate instrument for field validation [...] Ideally, it would be desirable to be able to display multi-date layers of information [...]". They also identified the following needs: "more flexibility in displaying images (size, resolution, etc.)"; "More flexibility and interactivity, for example, by enabling the integration of geospatial data, or facilitating note-taking in a form".

One teacher also added: "Now that I know more about the possibilities and limitations of the application, I would probably be able to make better use of it by making some changes. For example, by adding sample observation points to the observation points students need to make. Guided examples could draw students' attention to details they may not have noticed before, which could better prepare them to make their own observations".

Discussion

All the results lead us to draw a generally positive assessment of this second iteration. The application and its adaptation as designed by the team, generally meet the needs of the teachers and students of the courses. A relatively encouraging appropriation of the application was observed, thus inviting us to continue with exploring this platform or platforms that offers similar functionalities.

According to the results, teachers and students seem to have easily appropriated the use of the mobile application or the creation and experimentation of field-trips. This is a very encouraging first-step, but more investigation needs to be done in order to understand what led to the aforementioned observation. It can indeed have been caused by the proper resources and accompaniment offered, or because the technological knowledge of teachers and students, was already high enough to allow them to take full advantage of the technology. However, it is important to note here that the creation of the field-trips themselves was not done by the teachers, but rather by our team's assistant, who had to learn programming from scratch, as well as notions of pedagogical engineering, in order to translate the pedagogical demands of teachers into media form. None of the teachers took part in the programming of the field-trips. Even though the teachers mentioned that this application enables a more user-friendly approach, we should be more cautious about the difficulties that the programming aspect might entail. We can also question the necessity of such a heavy protocol in the creation of simple field-trips. Should it be necessary to hire an assistant to create and program each field-trip developed by a teacher?

Work at the level of social influence must also be conducted, which leads us to believe that greater implementation of the program approach (Loisy & Coulet, 2017) should be considered in order to emphasize the use of the application and to more fluidly integrate it in all the courses. On the other hand, we can also question wether or not the fact that we used the TaleBlazer application, which is originally designed for children and for fun, may have been an important factor that influenced the perception of the participants regarding the value of the application and its potential use in their future professional endeavours.

The results also demonstrated that the students see some light potential in this application when it comes to supporting them in achieving a higher level of performance (performance expectancy). If we link this to the comments made by the teachers, we can understand that some support should be offered to the teachers in order to reinforce their pedagogical use of the platform, so that students see a more positive impact on their learning. Teachers didn't seem to have a sufficient vision of all the possibilities offered by the application, and the possible ways to create meaningful field-trips. Work should therefore be done in order to strengthen the quality and the efficiency of the activities created with the help of the application. This also leads us to question the quality of the activities based on situated learning. Did the teachers succeed in creating field trips that allowed students to interact with the real environment and benefit from it as strongly as situated learning enables? Consideration of the climate issues raised by the teachers shows that it is possible to enrich the quality of situated learning, but that pedagogical support will have to be provided. This is in order for the teachers to design pedagogical situations that are more attentive to the aforementioned issues, while not being limited by technical constraints.

We found notable differences distinguishing between the different results obtained as part of the four participating courses. Many assumptions can be made in this regard. For example, the GAE700 course field-trip generally received the highest scores in the analysis, particularly with respect to the overall assessment. This can be explained by the fact that this field-trip was, during the project's first iteration, the focus of the development process. In particular, this field-trip benefited from a pedagogical design that was supported by two professionals in the field. Its adaptation for the second iteration also led to more improvements. This field-trip has a greater maturity than the others and has benefited from strong pedagogical support. This illustrates the importance of these factors in the performance of this kind of pedagogical activity. This course also relied much more on active learning principles, and led students to be very engaged in different activities such as surveys, data collection, case studies, etc. It will therefore be important, in future iterations, to carefully guide teachers in creating varied in situ activities that go beyond simple observation or collection of multimedia artifacts. It should also be noted that none of these field trips really involved game activities, and, therefore, although the design of the device was based on the principles of serious games, none of the field trips themselves responded to these principles. This is an avenue that deserves to be further explored, and which would, we hypothesize, have the capacity to create greater acceptance and, more specifically, a higher performance acceptance level.

On the other hand, we can observe that the field trip of the GMQ712 course has received relatively low scores for several elements of the analysis, such as *Performance expectancy* and *Adequacy of the tablet in a field trip*. These elements question the ergonomic constraints associated with this type of equipment for outdoors use. If the weather conditions are not favorable for the field-trip and limit the use of the tablet, it may affect the overall appreciation of the output, which would explain the lower scores received by GMQ712 compared to to other courses. The case of GMQ712 also illustrates a situation where some students questioned the usefulness of this kind of application for reaching the learning objectives of the field-trip. Either these objectives were not clearly identified for the students, or they could have been reached more simply, without relying on the application. This last point is important because it emphasizes the importance of evaluating the pedagogical utility of digital tools to meet a set of objectives. It might be tempting to integrate various technologies into courses, but that does not automatically improve the educational content.

Furthermore, we can see that the students demonstrate a sufficiently high level of digital literacy so that the technical appropriation of such a platform is not an issue for them. On the other hand, from the teacher's point of view, this appropriation appeared to be more challenging and their digital literacy seemed less sufficient. This can represent a significant obstacle to pedagogical creativity (Roy, Gruslin et Poellhuber, 2020; Siemens, Gašević, Dawson, 2015).

However, while our data do not allow for the clear identification of the reasons and causes of these differences, it clearly indicates that the application itself is not the only guarantor of its acceptance by students. It is also not a guarantee of the pedagogical quality of activities that are created through it.

Besides the technical difficulties that have been previously mentioned, and on which we will work carefully, these results led us to formulate propositions we want to explore in the next iteration. First of all, new user stories will have to be identified, and some will be made more specific. The comments made by the teachers and the students helped identify new actions that should be made possible within the app, like taking notes, collecting artifacts, visualizing multiple layers of information, or interacting with peers. These new user stories will most likely lead us to choose between different possibilities: 1- Collaborating with the Taleblazer's development team and programming and implementing new functionalities; 2- Selecting another existing application that offers functionalities that are more closely related to the teachers' and students' needs; 3- Developing our own application that will fulfil the needs of all the user stories. This choice will have to be made according to the financial support we can get from our institution or other sources of funding, as the different scenarios we mentioned have drastically varying financial requirements.

As for the research about the acceptance of the proposed technology by the participants, we will base our future work on the different researches that have recently been published such as "Factors Influencing Students' Acceptance in m-Learning" (Abu-Al-Aish & Love, 2013; Navarro, Molina & Redondo, 2016). These are indeed more appropriate to the kind of technology and activities that are experimented with in our own work. But mostly, if we want to make sure that we achieve the pedagogical goals identified in this project, we need to pay increasing attention to our central pedagogical frameworks (Situated learning, Active learning, Serious game). We also need to ensure a successful implementation and according to Abu-Al-Aish & Love (2013), "the successful implementation of mlearning in higher education will be based on users' acceptance of this technology" (p. 1).

Conclusion

This article aims to introduce a design-based research work whose primary goal is to improve hybrid training during a master's degree program in geomatics. This is done by introducing a mobile application, as well as varied resources, that will support the creation of digital field trips. This project is in its second iteration and allowed for the exploration and adaptation of an existing application initially designed for the creation of treasure hunts. It has also enabled the development of a techno-pedagogical approach that supports instructional design and the creation of self-guided field trips.

There are several scientific limitations to this project. First, as previously mentioned, only a small number of students responded to the questionnaires, so it is impossible to establish meaningful results per se and no generalizations can be made. The number of participating teachers was even smaller, and in their case it is not even possible to identify trends. Further qualitative work would have allowed for a better understanding of the acceptance level of these different individuals, as well as a better identification of the impactful factors. Furthermore, we compare field trips as if they were identical in their pedagogical approach and structure. However, we found that the impact on the acceptance of a given digital tool is strongly related to the pedagogical approach implemented. We believe that more targeted work that would for instance focus on one field trip at a time could be carried out in order to better distinguish the pedagogical characteristics that influence acceptance. Moreover, we should not forget the desirability bias that may have influenced some students whose teacher also happened to be the leader of this specific project.

These limitations, but also the results of this project, allow for the identification of interesting future research opportunities. This project confirms that the acceptance of educational technologies is strongly linked to the pedagogical uses that are made of them. Future research should be conducted in order to enrich the UTAUT model with regard to the pedagogical dimensions involved in the use of the aforementioned technologies. Furthermore, this project has shown that digital literacy is a key factor in student acceptance, but also in the pedagogical use that is proposed by teachers. It would be interesting for future research to explore the real impact of digital literacy and its ensuing effects on acceptance.

A design-based research project has multiple strengths and this specific project is a great example. Field trips created and experienced by the students in the early stages of the research, which is an important advantage, as it was not necessary to wait for all the research results to come in to start using the digital application. The participating teachers were at the heart of the developments process and were able to benefit from the close support of the research team which in turn contributed to the advancement of the project. Their contribution was therefore considerable while they simultaneously benefited from professional development in the field of pedagogical engineering.

The next iteration will be based on rich information and will offer important improvements that will significantly contribute to the quality of the new learning methods that COVID-19 has imposed on all of us and that are supported by the the Digital Action Plan for Education and Higher Education.

Notes

[1] http://www.education.gouv.qc.ca/en/current-initiatives/digital-action-plan/digital-action-plan/

[2] http://web.mit.edu/mitstep/projects/taleblazer.html

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Pour citer cet article

Meyer, F. et Théau, J. (2022). Stand-alone Field Trips Based on Geolocation as a Meaningful Source of Learning for Geomatics Students. *Formation et profession, 30*(3), 1-17. https://dx.doi.org/10.18162/fp.2022.645