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Developing professional development programmes with gamification for mathematics teachers in Uruguay

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Uruguay is a country with an extensive government policy providing all teachers and students laptops and connectivity. In order to carry out new professional development programmes for teachers of mathematics to use digital technologies in classrooms, we developed a qualitative study, collected data, and analysed teachers' concerns and needs for classroom-based technology use, identifying a set of guidelines to assist teachers. The programme was designed to offer teachers key experiences that can help them to achieve their didactical goals. As traditional courses and assessment did not address the detected needs, game components were incorporated into the teacher training programme. Gamification contributed to the solution of several problems such as formal assessment, certification, passing grades, adaptive content and self-evaluation. This paper reports and links two studies about identifying teachers' needs and the impact of a gamified professional development programme developed in Uruguay.

Keywords: Teacher education, professional development, gamification, technology uses in education.

Introduction

Uruguayan schools were transformed in the past decade, because of the utilisation of digital technologies for educational purposes. *Plan Ceibal*, a government policy that has provided a laptop to each student and teacher in public schools for more than a decade now, as well as connectivity all over the country, significantly changed classrooms in Uruguay (Plan Ceibal, 2017).

The new presence of digital technologies was challenging for teachers, who had to face these changes on their own, or supported by special, but often ineffective, professional development programmes. Such transition for teachers was not easy, especially because of some characteristics of Uruguayan teachers of mathematics: most of them have multiple jobs (60% teach in at least two schools), there is an important deficiency in their training (only 1 out of 3 of those who are teaching mathematics at middle schools finished their basic teacher's training) and they do not have enough time for attending professional development activities (paid hours are only for teaching) (INEEd, 2017; González, González, & Macari, 2013).

Consequently, professional development was required by teachers and strongly encouraged by authorities and supervisors. Nevertheless, as Assude, Buteau, and Forgasz (2010) state and our research confirmed, these activities did not significantly impact teachers' everyday lessons. The problems of identifying professional development programmes' long-term impact and promoting their sustainability have been analysed in several contexts (Loucks-Horsley, Stiles, & Hewson, 1996; Zehetmeier & Krainer, 2011; Zehetmeier, 2017).

Teachers and their supervisors agree about the minimal impact of existent professional development programmes on technology transition. Thus, we carried out a first qualitative study to identify the key aspects that should be addressed in these programmes to assist mathematics teachers to utilise didactical advantages of digital technologies on a regular basis.

This paper summarizes results of the first phase of this study and reports on subsequent research: after designing and implementing a professional development programme according to the key aspects we found, we analysed its impact based on teachers' perceptions. The unexpected appearance of gamification elements when designing the programme resulted in an interesting and challenging contribution.

How to assist teachers of mathematics to improve their technology-based lessons?

The first part of this study suggested two key aspects of professional development, as follows.

Research design and methods

The major research question of this phase was: What key aspects should be addressed in a professional development programme for mathematics teachers in Uruguay to assist them to utilise didactical advantages of digital technologies on a regular basis?

Experts who were interviewed suggested that this question had been discussed by national supervisors and trainers, but they provided unclear answers. We wanted to investigate teachers' concerns and difficulties, but letting other relevant key elements emerge as well. Thus, we decided to design a qualitative study based on a Grounded Theory approach (Glaser, & Strauss, 2009). Experts, teachers and their supervisors participated in (13) semi-structured interviews. Participants were asked about their and trainees' concerns; the obstacles teachers encounter while trying to use technologies in their classrooms; and also about their personal experiences of learning/teaching with technologies.

Data were processed using TAMS Analyzer (Weinstein, 2015), identifying emerging concepts through coding and recoding the interview transcriptions. This process let us also detect topics participants addressed spontaneously, which were not directly asked by the researchers. We can assume that if certain subjects show up regularly, even with no explicit questions, they might be closely related with our study aims (Cohen, Manion, & Morrison, 2015).

In order to offer more comprehensive answers to the research question, scientific literature was reviewed and integrated (e.g., Assude, Buteau, & Forgasz, 2010; Fullan, 2016; Loucks-Horsley, Stiles, & Hewson, 1996; Zehetmeier & Krainer, 2011).

Findings, first set: Obstacles and concerns

Interviewees were asked about the obstacles teachers encounter while they try to use digital technologies in their teaching. We detected four main obstacles: (a) a lack of *resources*: teachers say that devices do not work as expected, there are technical issues, connectivity fails, and it is not true that every student has a functioning computer because they are often broken; (b) a lack of *time*: teachers point out that it is very difficult to plan different lessons, as they do not have enough time to do so; (c) a lack of *feedback*: teachers say that they need to be encouraged by principals and supervisors to change their ways of teaching, otherwise they feel that they might not be working as

they should; and (d) a lack of *confidence*: teachers are taken out of their comfort zones, so they might need assistance and encouragement to believe in their own teaching skills in technology-assisted environments.

We also investigated teachers' interests and concerns regarding training topics. The data showed that teachers' concerns evolve gradually. Inexperienced and untrained teachers usually belong to the first step, and experienced trainers are placed in the top one (Figure 1). Each teacher recognizes other steps; nevertheless, they point out that the most concerning one is their own. Those who are at the top of the stairs declare that they have been in the previous stages before, but thanks to experience and training their concerns evolved. Steps are represented in Figure 1 and explained



below.

Figure 1: Teachers' concerns

Usage: teachers think that they need to be skillful at using software to be able to use it in their classrooms.

Potential: teachers understand that knowing what is possible to do with computers is more important than knowing how to do it.

Pedagogy: teachers are concerned with how technologies could help students to understand mathematical concepts.

Adoption: using technologies in classrooms on a regular basis is even more important, because otherwise learning is not as meaningful as it could be.

Benefit: teachers are focused on students and their learning outcomes, and they think that if everything else does not help you achieving the main goal then that is not important.

Teachers usually recognize the steps that they already went through, but they do not clearly visualize themselves in the higher stages. According to supervisors and experts, teachers should be assisted to be raised to higher steps as quickly as possible, because that means important improvement in their skills.

These findings are also consistent with previous research in the same topic (Biehler & Nieszporek, 2017; Liu & Huang, 2005; Loucks & Hall, 1979).

Findings, second set: Collaboration and leadership

One of the unexpected results of this phase was the importance of collaboration among teachers. Even when teachers were not asked about it, they expressed that being part of a team and being able to discuss pedagogies was a condition to improve their skills and learn how to use technologies in their lessons. Every interview suggests that it is not possible to evolve without teamwork.

Schools' leadership style also arose unexpectedly as a key aspect. Flexible rules, less bureaucracy and principals' good will are necessary conditions for teachers to improve their technology-assisted teaching skills.

Findings, third set: Innovation and motivation

In addition to the findings from the gathered data, we should also pay attention to the scientific literature on pedagogical innovations. Teachers adopting technologies on a regular basis arose as an important educational change in several aspects (Berman, 1981; Fullan, 2016). In order to assist teachers in this process, the complexity of every innovation should be carefully monitored.

Using multiple resources to keep and raise teachers' motivation at a high level is also essential, because the Uruguayan educational system does not offer them significant rewards for attending professional development programmes.

Preliminary conclusion: A set of guidelines, a set of experiences

We can summarise the previous findings in the following set of guidelines, which describe the key aspects of a professional development programme that should facilitate teachers' development with technology:

(1) Assist teachers to face the typical obstacles by teaching them particular solution strategies; (2) offer them various topics during courses according to each step of concerns (Figure 1) and try to guide them to be raised to the subsequent step, this should be done individually considering teachers' specific needs; (3) encourage them to collaborate, we discovered that it is a crucial aspect for their development; (4) guarantee schools' support to teachers (principal and supervisors should agree with the courses, computers must be available, etc.); (5) remember that the patterns of every innovation apply; and (6) keep motivation level as high as possible through various strategies (discussed in previous papers in detail).

It is important to point out that, according to interviewees, teachers' learning is associated with certain vital experiences in their teaching careers, but maybe not to traditional courses. If a traditional course makes a change in participants, it means the course promotes these key experiences (i.e., it includes collaborative planning, observing lessons, being observed, discussing pedagogies and results, etc.). As Loucks-Horsley, Stiles, & Hewson (1996) state, it is necessary to provide teachers with opportunities to develop knowledge and skills, but it seems that courses with a traditional format are not sufficient.

A pilot programme from a new perspective

The first part of this study highlighted that professional development activities for Uruguayan mathematics teachers do not fully satisfy their needs; thus, they are not completely sufficient for their development. Experts, teachers and their supervisors expressed that courses are interesting and you can learn because of them, but they only slightly affect their pedagogies.

Through the comparison of courses and guidelines, we can detect that numerous training conditions were satisfied, such as supporting innovations' characteristics and helping teachers to tackle common obstacles. Missing points are detected: course syllabi are rigid and therefore they do not care about individual concerns, and the formal structure of a course does not guarantee the crucial experiences like collaboration, team planning, lesson observation and discussions, etc. Even when

collaboration was encouraged in best-rated courses, assessment was based on traditional methods, such as tests, examinations, writing or presenting. As Zehetmeier & Krainer (2011) recommend, “Considering and facilitating these fostering factors (and at the same time avoiding the hindering factors) when designing and implementing professional development projects is one important step on the journey to sustainable in-service teacher professional development”.

One of the main challenges for professional development programmes seems to be reassuring teachers that they will experience what is needed for them to learn, and also taking those experiences as valuable components of the certification process. We designed a pilot professional development programme, which implemented every guideline and we tried it in different courses. We outline here the main characteristics of that programme.

In order to increase teachers’ motivation and help them to overcome the common obstacles, agreements with schools and training institutes were signed. Schools would guarantee adequate conditions for teachers (fully working devices, availability of computer laboratory, flexibility with teacher to observe colleagues’ lessons) and the training institute would issue certificates.

The basic structure was a traditional online course (because teachers do not have time for face-to-face workshops), four months long. 16 participants began the course and 4 of them finished, which is a more than acceptable ratio for an online free course. Through detecting teachers’ interests (by questionnaires and analysis of forum posts), the moderator assigned special materials and tasks to each participant, addressing personal concerns and expectations.

Assessment was designed to oblige teachers to go through the key experiences, so it was mandatory to work together, observing lessons, welcoming someone else into his/her classroom, giving feedback, etc. A multi-dimensional credits system was designed to establish the passing point, thus key experiences were not avoidable. From the very beginning, teachers knew how many credits of each kind they needed to be able to pass the course. Nevertheless, there was also a minimum total amount of credits they had to collect; getting the minimum of each type would not be enough, they had to go deeper and obtain more credits in any aspect they preferred.

This assessment and certification system led us to a complex set of rubrics; it was accurate and let us achieve our goals, but it could be confusing for teachers, hindering motivation and transparency. This led to the emergence of gamification components in the study.

We represented the credits with colourful stars (one colour for each dimension), so the goal was to collect as many stars as possible. We designed a personal dashboard (Figure 2) for each participant, in which you could see how many stars you have, which colours are missing and how to obtain them.

In this case, game elements are not changing the essence of the design, but they only make it nicer. As Stott & Neustaedter (2013) explain, most of what gamification, in the sense of Deterding *et al.* (2011), implies is already recognized and utilized in school, although under different designations.



(Cohen, Mamon, & Robinson, 2015).

An online platform (learning management system) was analysed. Questionnaires (to identify main concerns) and several interviews and lesson observations were conducted. The data was transcribed and processed with qualitative analysis. Some of these data were used during the course to address concerns.

Preliminary findings

The analysis showed that teachers were pleased with the flexibility of the programme; they enjoyed that content was adapted to their concerns and they actually tried out in their classrooms what they learnt. All teachers expressed that this experience changed the way they think about teaching; suggesting that an important modification in their perceptions happened, that can be associated to a progress in the concerns model. They found the opportunity in this programme to develop their skills and knowledge (Loucks & Hall, 1979). They also expressed that assessment was a bit overwhelming at the beginning, but afterwards the funny stars and the dashboard made it easier, motivating them and eventually they were not worried about certification. Game elements helped them in terms of self-assessment and motivation.

Discussion

We began thinking about the contribution of gamification in teacher training as a necessity to motivate teachers and change the environment of the teacher-training course. Understanding gamification as the utilisation of game components in non-game contexts (Deterding et al., 2011), using game elements like collection of stars and personal dashboards helped us to deal with the complexity of the course's design. We cannot assume that the presence of gamification elements is the reason for the course to be successful (Dicheva et al., 2015), we need further measurement of changes (Stott, & Neustaedter, 2013). There are also drawbacks in the integration of gamification in education (Hanus & Fox, 2015), but based on our experiences and this study there are good prospects for further developments.

This study confirmed that it is possible to design a professional development programme for teachers, which has serious assessment and certification, but is based in key personal experiences, adapted to different concerns and expectations (Loucks & Hall, 1979). Traditional methodologies should be modified to achieve this goal, but it can be done as demonstrated above.

-  **GREEN credits**
Constancy and responsibility award. You can gain them by doing your tasks (forum and questionnaires) on time.
-  **GREEN credits**
Technical knowledge award. You can gain them by participating (asking or answering) in the Technical forum.
-  **RED credits**
Pedagogical reflection award. You can gain them by participating (asking or answering) in the Pedagogical forum.
-  **YELLOW credits**
Generosity and collaboration award. You can gain them by sharing pedagogies and teaching resources, and leaving comments to colleagues' resources as well.
-  **ORANGE credits**
Criticism award. You can gain them by observing colleague's lessons and giving feedback.
-  **LIGHT BLUE credits**
Humility award. You can gain them by letting a colleague observe your lesson, and making self evaluations as well.

This is the minimum amount of each star you need to pass the course:



Gamification arose as an unexpected ally, simplifying assessment, enhancing motivation and offering new opportunities for adaptive content. Thus, we believe that teacher training courses with gamification elements should be designed and further researched.

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