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Exploring the use of educational technology in primary education: Teachers' perception of mobile technology learning impacts and applications' use in the classroom

Marta Gómez Domingo*, Antoni Badia Garganté

Department of Psychology and Educational Science, Open University of Catalonia, Doctoral School, Av. Carl Friedrich Gauss, 5, 08860 Castelldefels, Spain

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ABSTRACT

Mobile technology has become popular worldwide with a broad range of users, including students from all levels of education. Although the impact of mobile technology in classrooms has been extensively studied, less is known about teachers' perceptions of how mobile technology impacts in learning and its relation to Applications (Apps) use in the classroom. This state of affairs is problematic since we know that teachers' perceptions have a great influence on their teaching practices. This study used survey data gathered from 102 teachers of 12 different primary schools in Spain. The questionnaire collected data about teachers' individual information, teachers' perceptions on the impact of mobile technology in learning, and use of a set of selected Apps in the classroom. Findings suggest that facilitating access to information and increasing engagement to learning are the two main impacts of mobile technology in the classroom. Findings also show that the choice of Apps is related to the teachers' perception of how mobile technology impacts in learning. Findings could help teachers to take advantage of the combination of affordances of mobile technology and Apps that actually improve some aspects of learning practice.

1. Introduction

Mobile technology, such as Tablet and Smartphone, has become popular worldwide with a broad range of users in classrooms, including students from all levels of education (Dhir, Gahwaji, & Nyman, 2013; Kinash, Brand, & Mathew, 2012). The success of Smartphone and Tablet computers is one example, strongly related to remarkable growth of Internet applications specially developed for those devices.

Increased affordability and functionality have been highlighted as partly explaining the attractiveness of mobile devices in education (Kinash et al., 2012). Although the potential positive impact of mobile technology on learning in schools has been widely acknowledged (Falloon, 2013), more research is needed to design appropriate guidelines for new curricula and pedagogy to support and assess the use of mobile technology in schools (Dhir et al., 2013).

In consequence, the purpose of the present research is to explore in depth the teachers' perceptions of the impact of mobile technology in learning in primary education, and how these perceptions could influence the use of specific Apps in the learning process.

2. Theoretical background

2.1. Adoption of new media to facilitate knowledge sharing in classrooms

According to user commitment theory and continuous adoption of technology (Zhang, de Pablos, Wang, et al., 2014), usefulness, ease of use, personalization and learning cost are the main variables that affect people's adoption of new media. Social media possesses some of these features, in addition to immediacy. For this reason, this new media combined with mobile learning becomes a good instrument for pedagogical transformation (Agichtein, Castillo, Donato, Gionis, & Mishne, 2008; Cochrane & Rhodes, 2013; Zhang, Wang, de Pablos, Tang, & Yan, 2015). This relation between learners' perception and the adoption of new media could be

* Corresponding author.
E-mail addresses: martagomezdomingo@uoc.edu (M.G. Domingo), tbadia@uoc.edu (A.B. Garganté).

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clearly observed in a classroom setting. Chen and Huang (2010) found out that perceived ease of use of mobile knowledge management learning systems can positively predict perceived usefulness by learners, and perceived usefulness is the key factor for learners' willingness to be guided through a system's learning process.

For institutions that have decided to adopt social media, it has been proved that it could become an excellent instrument to promote knowledge sharing among members. Social media has brought great challenges and wonderful opportunities for organizational learning. With support of social media, organizations facilitate the knowledge management process by encouraging employees to promote collaborative learning behaviours from e-learning to social learning (Zhang, Gao et al., 2015). In multinational virtual classes, two intrinsic benefits in sharing knowledge have been identified: a) Self-efficacy: when participants contribute their useful knowledge, they will have higher confidence in themselves; and b) Enjoyment: when participants' contributions are found useful and even adopted by others, they will experience higher levels of happiness (Zhang, de Pablos, & Xu, 2014).

It has also been shown that the adoption of mobile learning in classrooms promotes knowledge sharing among students. Mobile learning proved to be useful in helping learners to share knowledge and create social interaction (Suanpang, 2012), and the use of Mobile learning Mindtools was demonstrated to be useful in improving learners' knowledge structure as well as their learning achievements.

2.2. Mobile technology learning impact in classrooms

Teachers' perceptions about the impact of mobile technology in learning reflect their beliefs about how this technology influences learning processes (Ertmer, 2005). Whereas teachers' knowledge about the use of technology in classrooms generally refers to factual propositions and understandings, beliefs refer to suppositions, commitments, and ideologies about the impact of technology in learning. Understanding teachers' perceptions of mobile technology provides a means for promoting a more meaningful use of this technology in the classroom setting.

An extensive body of research determines that teachers' perceptions of positive impact of technology, that is, the instructional benefits of technology are significant and positively correlated with the use of technology in classrooms (e.g., Badia, Meneses, Sigalés, & Fàbregues, 2014; Inan & Lowther, 2010; Van Braak, Tondeur, & Valcke, 2004), and also with the use of mobile technology in classrooms (Boticki, Baksa, Seow, & Looi, 2015; Churchill & Wang, 2014; Furió, Juan, Seguí, & Vivó, 2015; Gerger, 2014; Jahnke & Kumar, 2014; Lu, Meng, & Tam, 2014; Murphy, 2011; Yang, Li, & Lu, 2015).

Proving new ways to learning has been demonstrated to be one of mobile technology learning impact. Furió et al. (2015) argue that thanks to mobile technology, children have the opportunity to explore what they are learning from a variety of different perspectives. Moreover, Boticki et al. (2015), highlight that mobile technology provides a range of new ways to learn, such as promoting authentic learning environments in the classroom thanks to mobile technology, allowing students to make connections to their classroom lessons on learning (Murphy, 2011).

Results showed that students are more engaged when learning is performed through mobile technology use (Lu et al, 2014). The level of engagement of students and their interest to accomplish educational tasks had increased in classes that used mobile technology (Gerger, 2014). In addition, since the mobile technology results in high motivational effects, it could be used as a tool in primary schools to reinforce students' learning process (Churchill & Wang, 2014).

Mobile technology has also been found to generate autonomous learning (Gerger, 2014). Moreover, mobile technology encourages pupils to take control of their own learning, allowing students to establish from their own learning goals until the final assessment of their own learning (Boticki et al., 2015). It has been demonstrated that mobile technology helps learners to manage their self-directed learning (Lu et al., 2014). Furthermore, mobile technology encourages students to be active leaders in the design of curriculum and instruction, as well as supportive coaches for their classmates (Gerger, 2014).

Facilitating access to information has been mentioned as an important mobile technology learning impact (Yang et al., 2015). Students' immediate access to internet resources, as well as capturing, storing, and managing everyday events as images and sounds are tasks empowered by the use of mobile technology (Churchill & Wang, 2014; Murphy, 2011). Moreover, mobile technology has shown to support the emergence of relevant thoughts or ideas to students' contribution in class (Furió et al., 2015).

Yet another important impact of mobile technology is its promotion of collaborative learning (Murphy, 2011). Mobile technology encourages interactivity and instant feedback, which facilitates cooperative learning and promotes peer collaboration, and collaborative feedback during the learning process (Jahnke & Kumar, 2014). Besides, it has been observed that mobile technology increases communication between pupils and teachers in the classroom. Students learn better because the mobile technology encourages student group work, helpful comments and rich discussions (Boticki et al., 2015). Moreover, students have shown to be simultaneously able to communicate and share the learning material found with classmates and with the world (Churchill & Wang, 2014).

In summary, the above-mentioned studies indicate that teachers' perceptions focused in five different kinds of impacts of mobile technology in learning (See Table 1): Providing new ways to learn, increasing engagement to learning, fostering autonomous learning, facilitating access to information, and promoting collaborative learning.

2.3. Types of applications used by primary pupils in the classroom

In our time, hundreds of thousands of specialized Apps are available to extend the functionality of mobile technology (Johnson et al., 2013). Apps in schools range from educational games to science and art Apps that enable users to explore outer space, the Louvre, and many other places that they may not ever get to see in person in their lifetimes.

It is this transformative nature of Apps that has helped mobile technology become a popular and powerful tool in education. Since 2010 some research investigating the use of Apps as an educational tool has been conducted, focussing the attention on different kind of Apps at different levels of education.

Falloon (2013) investigated the design and content features of forty-five Apps selected by an experienced teacher. From the broad range of Apps selected, 27 of them were considered educational Apps, which focused on content learning, such as: solving math tasks (e.g. Bubbling Math), improving numeracy skills (e.g. Connect the dots), reinforcing spelling (e.g. Rocket Speller Smarty Pants School), acquiring new vocabulary (e.g. Smarty Pants School), and improving phonetic (e.g. Mr. Phonics), among others. The rest of the Apps selected in the research were considered to be learning skills tools, allowing students to develop a variety of activities, such as: practicing writing skills (e.g. Magnet ABC), performing oral skills (e.g. Talking Tom and Ben News), rehearsing reading skills (e.g. Cat

Table 1
Authors' contributions to define the various impacts of learning with mobile technology.

Authors' contributions	Providing new ways to learn	Increasing engagement to learning	Fomenting autonomous learning	Facilitating access to information	Promoting collaborative learning
Murphy (2011)	Offer a variety of learning environments.			Immediacy of access to digital content.	Generate students' collaboration which is an essential element in the generation of meaningful and individualised knowledge.
Gerger (2014)		Students' interest to accomplish educational tasks increases.	Empower students to be active leaders in design of curriculum and instruction.		
Churchill and Wang (2014)		Raise students' satisfaction in learning.		Empower students to access internet resources.	Allow students to communicate and share the material with classmates and throughout the world.
Lu et al. (2014)		Greater students' learning engagement.	Supports self-paced individual learning.		
Furió et al. (2015)	Students learn from a variety of different perspectives	Enhance learners' motivations to learn.		Increase access to hypermedia learning material.	
Jahnke and Kumar (2014)	Connect reality to the learning content			Develop searching informational skills.	Promote peer collaboration, and collaborative feedback during the learning process.
Boticki et al. (2015)	Provide a range of authentic learning environments		Encourage pupils to take control of their own learning.		Increase communication between pupils and teachers in classroom
Yang et al. (2015)		Boost students' engagement classes.		Retrieve information immediately.	Support face-to-face collaborative learning.

in the Hat (Lite)), and improving drawing skills (e.g. Doodle Buddy), among others.

Besides that, Martin and Ertzberger (2013) wanted to investigate if an Informational Management App improved student achievement and attitude when compared with computer based instruction. To achieve this purpose Lectora Inspire App was used to enable students to access information on different paintings. The App used was defined as Informational Management App because it has the ability to work within the specific context and environment of the learning and to increase the ease of informal learning by providing quick and easy access to information.

In a recent study by Kucirkova, Messer, Sheehy, and Fernández (2014), an App focused on learning skills, the story-making App called Our Story was compared to its engagement with a selection of content learning Apps based on completion and colouring activities. Findings showed that the quality of children's individual engagement was higher with the Our Story App in contrast to their engagement with other App software (e.g. Jigsaws 123, Kids' puzzle or Pick n Colour).

Focussing the attention on math Content Learning Apps, Cayton-Hodges, Feng, and Pan (2015) centre their research on a sample of sixty-four educational Apps from preschool to elementary school-aged children. The Apps selected covered a wide range of mathematics topics, including numbers and operations, algebra, geometrics, and statistics and probability.

Finally, Falloon and Khoo (2014) explored possible advantages of using three learning producing Apps (*Puppet Pals HD*, *Pic collage* and *Popplet*) in order to enable year one students to interact more collaboratively when creating learning outputs. Learning Skills Apps were defined as Apps that enable students to create their own knowledge by providing them with the accurate environment to construct their learning.

Taking into account all studies, three types of Apps used by Primary pupils in classroom can be identified: Learning Skills Apps, Informational Management Apps and Content Learning Apps. Learning Skills Apps enable students to create their own knowledge by providing them with the precise atmosphere to build their learning, whereas Informational Management Apps have the ability to work within the specific context and environment of the learning and have the ability to increase the ease of informal learning. Finally, Content Learning Apps are considered to proportionate students different activities that allow them to rehearse, reinforce, practice and assess curricular content.

We have considered it relevant to carry out an empirical study and provide a comprehensive overview of teachers' perception of the impact on learning of mobile technology, the frequency of use in the classroom of different types of Apps, and significant differences between Apps' users and non-users about the learning impact of mobile technology. These research questions are explored:

1) What is the impact on learning that teachers thanks to the use of mobile technology in the classroom?
2) What is the frequency of use of various Apps in the classroom?
3) What are the differences in the perception of the impact on learning of mobile technology among non-users/users of each App?

3. Research design

3.1. Context of the study

The research presented here is based on data collected from 12 schools that joined the project *Intercentres*, run by *Tr@ms Foundation*, with the aim of fostering the integration of educational technology in schools. The schools provided the best possible technological conditions of that time to their members. All 12 schools maintained a full technology infrastructure consisting of at least 30 tablets available to be used when requested by the teachers, complete Internet access anywhere through Wi-Fi, private educational Intranet for all members of school, more than 80 educational Apps including all curricular areas, freedom to download as many free educational Apps as desired, a flexible budget to buy new educational Apps and enough technical and pedagogical human support for the teachers in their own centre with at least one computer technician in each school.

3.2. Participants

Teachers belonging to the 12 schools that participated in the *Intercentres* project fulfilled a questionnaire specially designed to study tablets integration in schools. At the end of the research, 102 questionnaires were collected, belonging to 102 teachers that informed about the use of tablets and Apps' of 2550 pupils. It is important to mention that all teachers knew in advance how to use all the Apps that were employed in the study, as it was a requirement to participate in the study. Of the 207 teachers who teach in these schools, the questionnaire response rate was 49.2%. The school with the highest range of response was 19.7%, while the school with the lowest range of response was 1.6%.

The sample of participants consisted of 77.4% of women and 22.6% of men. The average age of participants was 44.8 years; 57.5% of teachers had a three-year Diploma, 31.1% had a Bachelor's degree, and 11.3% held a Master's or Doctoral degree. The average experience as teachers was of 19.73 years. When this research was carried out, teachers had used tablets in their classrooms for an average time of 3.74 years. Moreover, the teachers had received training on tablets uses of 3.45 on a scale from 1 to 5. This means that teachers had received training between "basic training (between 6 and 15 h)" and "advanced training (between 15 and 30 h)". The perception of the usefulness of this training was 3.78 on a scale of 1–5, ranging between "fairly useful" and "very useful".

3.3. Procedure and survey instrument

The research took place from September to December of the 2014, and complied with Open University of Catalonia ethics requirements, with standard informed consent procedures being followed throughout. A fifty-eight item Likert and short response online survey was developed and administered using *GoogleForms*. The researchers provided the website with the online questionnaires to the headmaster of each school, and each headmaster made sure to facilitate the website of the questionnaire to the teachers.

The first section (eighteen items) asked teachers for socio-professional background (7 items), training experience about mobile technology (3 items), initial teachers' experiences with mobile technology (3 items), and technological access conditions (5 items). Personal and professional background information was collected, including age, sex, education and qualification level, teaching experience and current teaching level. Technological access conditions were assessed using a 5-point Likert scale from 1 = "strongly disagree" to 5 = "strongly agree". All item of this section were adapted from previous studies (Badia et al., 2014).

The second section explored the frequency with which students use certain Apps in the learning process. It includes twenty items, and each item deals with a different App (Annex 1). Apps were selected according to three main criteria: a) There is a representative sample of all types of Apps identified in the theoretical background (Learning Skills Apps, Informational Management Apps and Content Learning Apps); b) All Apps are popular and well-known in primary education classrooms (Falloon, 2013); and c) Can be commonly used by all pupils of 12 schools. A five-level ordinal rating scale has been used, ranging from (1) Never used, (2) Monthly, (3) Fortnightly, (4) Weekly, (5) Minimum every two days.

The development of scales included in the third section has been done taking into account one previous questionnaire (Badia et al., 2014), and were informed by literature on learning impacts from mobile technology, reviewed in the theoretical background section (i.e., Boticki et al., 2015; Kucirkova et al., 2014; Li, Pow, Wong, & Fung, 2010; Looi et al., 2011). It includes twenty items, which reflects a wide range of potential learning impacts resulting from using mobile technology, and represents the teachers' perceived impact that using mobile technology plays in learning. A five-level ordinal rating scale, ranging from 1 = "strongly disagree" to 5 = "strongly agree" has been used.

The teachers' answers to all questions make reference to the classroom where they had more time dedication during the first quarter of the academic year 2014–2015.

3.4. Data analysis

The data were analysed using IBM SPSS Statistics for Windows, Version 21.0, and three consecutive steps of analysis were followed.

The first step entailed a data analysis of descriptive statistics of items related teachers' perceptions of learning impact of mobile technology. Types of learning impacts were grouped into scales according to their content, and descriptive statistics and Cronbach's α of each scale were calculated. Further, an overall index per person was calculated, addend the value of all items, and dividing the result by sixteen (the total of items).

In the second step, descriptive statistics of items of use of relevant Apps in classroom were calculated.

In the third step, a set of analyses of Student's t-test and, when required, Mann'Whitney U nonparametric test, were conducted to examine the differences between classrooms' users and non-users of each App, regarding all perceived learning impacts. The group of classrooms' users was delimited selecting only the classrooms that teachers indicated that each App has been used (App frequency of use > Never used). Levene's test was used to assess the equality of variances. When the test was significant, the Welch correction was also performed.

4. Results

In this section, we present the results sorted according to the research questions.

4.1. What is the impact of learning that teachers perceive achieve thanks to the use of mobile technology in the classroom?

Table 2 shows the descriptive results (mean and standard

Table 2
Descriptive statistics and scales' reliability of learning impact of mobile technology in classrooms (N = 102).

	M	SD
1. Providing new ways to learn. α=0.784	**4.07**	**0.64**
01 Promoting new ways of knowledge building	4.16	0.79
02 Improving the support of student diversity	4.13	0.78
03 Fostering meaningful and functional learning	3.97	0.80
04 Providing greater diversity of learning experiences	4.04	0.90
2. Increasing engagement to learning. α=0.808	**4.05**	**0.67**
05 Favouring the learning achievement of pupils	3.88	0.85
06 Keep learners engaged in assignment	4.01	0.81
07 Increased learner motivation to learn	4.12	0.90
08 Encouraging learner interest for learning content	4.20	0.78
3. Fomenting autonomous learning. α=0.755	**3.92**	**0.71**
09 Promoting decision making processes among learners	3.75	0.84
10 Promoting learner autonomy when learn	3.96	0.84
11 Facilitating learner self-assessment	4.05	0.91
4. Facilitating access to information. α=0.801	**4.10**	**0.71**
12 Improving information searching skills	4.15	0.81
13 Fostering the application of a variety of learning strategies	4.10	0.73
14 Enabling students to access to multiple sources of information	4.07	0.97
5. Promoting collaborative learning. α=0.743	**3.71**	**0.81**
15 Fostering collaborative learning among students	3.68	0.95
16 Encouraging work in team-based learning	3.75	0.88
6. Overall index. α=0.939	**4.00**	**0.61**

deviations) of teachers' perceptions of the impact on learning as a result of using mobile technology in classrooms. It also contains alpha reliability of multi-item scales.

Using mobile learning in classrooms have been seen by teachers mainly as a way to facilitate access to information (M = 4.10), provide new ways to learn (M = 4.07), and increase engagement in learning (M = 4.05). By contrast, collaborative learning is the least appreciated learning impact (M = 3.71).

Specific items that get higher scores deal with issues such as encouraging learner interest for learning content (M = 4.20), promoting new ways of knowledge building (M = 4.16), and improving information searching skills (M = 4.15). Conversely, items with lower punctuation were fostering collaborative learning among students (M = 3.86), encouraging work in team-based learning (M = 3.75) and promoting decision making processes among learners (M = 3.75).

4.2. What is the frequency of use of relevant Apps in the classroom?

Table 3 shows the descriptive results of the educational use of each App during classrooms' assignments. Each App have been described according to both the learning goal that a student could achieve using it, or the learning activity that usually they could do.

The Apps used for more classrooms (above 40%) are 3 Content Learning Apps (Pop Maths (52%), Bubbling Math (40.2%) and Connect the dots (48%)), 2 Informational Management Apps (Google Search (51%) and Google Earth (44.1%)) and 1 Learning Skill App (Pirate Treasure Hunt (43.1%)). Four of these Apps (17, 18, 19, and 04) used by more pupils, have in common that they encourage learning mathematics by content learning and learning skills through the curricular content. While, two of them (08 and 12) have in common that they enhance students' access to information.

The Apps used for fewer classrooms (below 25%) are 2 Informational Management Apps Times to Go (22.5%) and Sticky Icky Bathtime (21.2%), 2 Learning Skills Apps Gingerbread maker (18.6%) and PlayArt (24.5%) and 1 Content Learning App (Mr. Phonics (11.8%)). These 5 Apps fewer used by pupils have in common that they have little impact on content learning. Times to Go and Sticky Icky Bathtime are Informational Management Apps, and Gingerbread maker and PlayArt are Learning Skills Apps, which have no direct impact on content learning. However, when Apps have a content learning impact, such as Mr. Phonics, the learning content belongs to subjects that have a reduced dedication time in school timetable.

For classrooms' users, Apps more frequently used (at least weekly for more than 17% of classrooms) are 3 Content Learning Apps Pop Maths (29.4%), Bubbling Math (18.6%) and Connect the dots (18.6%), 1 Informational Management App (Google Search (27.5%) and 1 Learning Skills App (Doodle Buddy (17.6%)).

The Apps group more frequently used is Content Learning Apps, which have in common that they are drill-and-practice tools. Nevertheless, one App also of Content Learning category (Mr. Phonics) is the least frequently used (0% weekly), probably because it covers a very small field of content in learning timetable.

4.3. What are the differences in the perception of the impact on learning of mobile technology among non-users/users of each app?

Results identify connections between teachers' perceptions of learning impact of mobile learning and Apps' use, presented in Table 4.

Altogether, the data shows that only teachers who have used in their classes some Informational Management Apps: Search information (t = 2.584), Locate a geographical area (t = 5.071), and trace a route on a map (t = 2.442), or some Learning Skills Apps: Practice writing skills (t = 2.688), or Develop instructions given (U = 588.5) perceive significantly higher the overall index of learning impact of the mobile technology than teachers that have not used these Apps. The App that shows the highest difference between non-users and users is an informational management tool: Locate a geographical area (t = 5.071), following by a learning skills tool: Practice writing skills (t = 2.688).

Among Learning Skills tools, teachers' users of different Apps perceive significantly higher different learning impacts of mobile

Table 3
Frequency of use of each App during learning assignments (N = 102).

		Non users	Users			
		Never used	Monthly	Fortnightly	Weekly	>3 days
		N (%)	N (%)	N (%)	N (%)	N (%)
Learning skills tool						
01	Rehearse reading skills (Berenstain Bears Lite)	74 (72.5)	13 (12.7)	2 (2.0)	5 (4.9)	8 (7.8)
02	Practice writing skills (Magnet ABC)	68 (66.7)	15 (14.7)	5 (4.9)	11 (10.8)	3 (2.9)
03	Perform oral skills (Talking Tom and Ben News)	73 (71.6)	14 (13.7)	8 (7.8)	4 (3.9)	3 (2.9)
04	Apply math and literacy skills (Pirate Treasure Hunt)	58 (56.9)	21 (20.6)	8 (7.8)	11 (10.8)	4 (3.9)
05	Develop instructions given (Gingerbread maker)	83 (81.4)	7 (6.9)	6 (5.9)	5 (4.9)	1 (1.0)
06	Improve drawing skills (Doodle Buddy)	63 (61.8)	16 (15.7)	5 (4.9)	14 (13.7)	4 (3.9)
07	Create artworks (PlayArt)	77 (75.5)	19 (18.6)	2 (2.0)	3 (2.9)	1 (1.0)
Informational management tool						
08	Search information (Google Search)	50 (49.0)	14 (13.7)	10 (9.8)	12 (11.8)	16 (15.7)
09	Understand information (Times To Go)	79 (77.5)	11 (10.8)	2 (2.0)	7 (6.9)	3 (2.9)
10	Analyse information (Sticky Icky Bathtime)	80 (78.4)	8 (7.8)	6 (5.9)	7 (6.9)	1 (1.0)
11	Synthesize information (SimpleMind)	75 (73.5)	13 (12.7)	6 (5.9)	7 (6.9)	1 (1.0)
12	Locate a geographical area (Google Earth)	57 (55.9)	21 (20.6)	11 (10.8)	11 (10.8)	2 (2.0)
13	Trace a route on a map (Google Maps)	68 (66.7)	17 (16.7)	7 (6.9)	9 (8.8)	1 (1.0)
Content learning tool						
14	Acquire new vocabulary (Smarty Pants School)	72 (70.6)	14 (13.7)	3 (2.9)	12 (11.8)	1 (1.0)
15	Reinforce spelling (Smarty Pants School)	69 (67.6)	14 (13.7)	5 (4.9)	11 (10.8)	3 (2.9)
16	Improve phonetics (Mr. Phonics)	90 (88.2)	5 (4.9)	7 (6.9)	0 (0.0)	0 (0.0)
17	Solve math quiz (Pop Maths)	49 (48.0)	14 (13.7)	9 (8.8)	25 (24.5)	5 (4.9)
18	Solve math tasks (Bubbling Math)	61 (59.8)	12 (11.8)	10 (9.8)	16 (15.7)	3 (2.9)
19	Improve numeracy (Connect the dots)	53 (52.0)	13 (12.7)	17 (16.7)	16 (15.7)	3 (2.9)
20	Assess the work done (Cut the Rope)	71 (69.6)	12 (11.8)	8 (7.8)	9 (8.8)	2 (2.0)

Table 4
Differences of teachers' perception of instructional benefits depending on their use in classrooms (Non-users/users) (N = 102).

	1. New ways to learning			2. Learning engagement			3. Autonomous learning			4. Access to information			5. Collaborative learning			6. All learning impacts		
	No users	Users	Sig.	No users	Users	Sig.	No users	Users	Sig.	No users	Users	Sig.	No users	Users	Sig.	No users	Users	Sig.
	M (SD)	M (SD)		M (SD)	M (SD)		M (SD)	M (SD)		M (SD)	M (SD)		M (SD)	M (SD)		M (SD)	M (SD)	
Learning skills tool																		
01 Rehearse reading skills (Berenstain Bears Lite)	3.99 (0.70)	4.22 (0.53)	U = 903.5	3.97 (0.72)	4.20 (0.55)	U = 913.5	3.77 (0.77)	4.24 (0.40)	U = 628.0[b]	4.02 (0.79)	4.23 (0.57)	U = 950.5	3.70 (0.88)	3.68 (0.60)	U = 1053.0	3.91 (0.68)	4.15 (0.44)	U = 860.0
02 Practice writing skills (Magnet ABC)	3.96 (0.66)	4.25 (0.64)	t = 2.140[a]	3.92 (0.68)	4.26 (0.66)	t = 2.419[a]	3.73 (0.70)	4.24 (0.65)	t = 3.538[b]	3.97 (0.77)	4.28 (0.67)	t = 2.032[a]	3.60 (0.84)	3.88 (0.72)	t = 1.666	3.86 (0.64)	4.21 (0.58)	t = 2.688[b]
03 Perform oral skills (Talking Tom and Ben News)	4.06 (0.68)	4.04 (0.65)	U = 1071.0	4.05 (0.69)	3.97 (0.66)	U = 1003.5	3.86 (0.74)	3.99 (0.67)	U = 984.0	4.13 (0.77)	3.92 (0.66)	U = 872.5	3.70 (0.86)	3.67 (0.67)	U = 1116.0	3.99 (0.66)	3.95 (0.58)	U = 1065.5
04 Apply math and literacy skills (Pirate Treasure Hunt)	3.98 (0.76)	4.16 (0.49)	t = 1.402	3.93 (0.79)	4.16 (0.47)	t = 1.892[a]	3.83 (0.81)	3.98 (0.58)	t = 1.013	3.99 (0.85)	4.19 (0.57)	t = 1.361	3.62 (0.94)	3.80 (0.58)	t = 1.095	3.90 (0.74)	4.09 (0.43)	t = 1.532
05 Develop instructions given (Gingerbread maker)	4.00 (0.70)	4.25 (0.46)	U = 684.5	3.98 (0.72)	4.24 (0.43)	U = 667.0	3.85 (0.76)	4.11 (0.47)	U = 668.0	4.01 (0.78)	4.35 (0.48)	U = 629.0	3.64 (0.83)	3.95 (0.64)	U = 633.5	3.93 (0.67)	4.20 (0.38)	U = 588.5[a]
06 Improve drawing skills (Doodle Buddy)	4.02 (0.71)	4.11 (0.59)	t = 0.652	4.01 (0.71)	4.06 (0.67)	t = 0.326	3.98 (0.74)	3.75 (0.67)	t = −1.603	4.04 (0.80)	4.13 (0.67)	t = 0.562	3.70 (0.87)	3.66 (0.70)	t = −0.181	3.97 (0.67)	3.98 (0.58)	t = 0.017
07 Create artworks (PlayArt)	4.04 (0.66)	4.08 (0.71)	U = 1000.5	4.03 (0.68)	4.01 (0.71)	U = 980.0	3.93 (0.72)	3.79 (0.71)	U = 894.0	4.08 (0.75)	4.04 (0.75)	U = 966.0	3.69 (0.82)	3.72 (0.80)	U = 985.5	3.98 (0.63)	3.96 (0.67)	U = 973.0
Informational Management tool																		
08 Search information (Google Search)	3.92 (0.70)	4.19 (0.61)	t = 2.167[a]	3.86 (0.72)	4.21 (0.61)	t = 2.709[b]	3.83 (0.76)	3.96 (0.68)	t = 0.959	3.86 (0.79)	4.29 (0.64)	t = 3.027[b]	3.50 (0.85)	3.89 (0.72)	t = 2.573[a]	3.82 (0.68)	4.13 (0.55)	t = 2.584[a]
09 Understand information (Times To Go)	4.07 (0.68)	3.99 (0.63)	U = 913.0	4.04 (0.70)	3.98 (0.65)	U = 923.0	3.92 (0.75)	3.78 (0.59)	U = 811.0	4.05 (0.77)	4.16 (0.68)	U = 872.5	3.70 (0.84)	3.67 (0.70)	U = 949.5	3.98 (0.65)	3.94 (0.57)	U = 940.5
10 Analyse information (Sticky Icky Bathtime)	4.06 (0.68)	4.01 (0.64)	U = 895.5	4.05 (0.70)	3.94 (0.65)	U = 825.5	3.89 (0.75)	3.89 (0.63)	U = 922.0	4.08 (0.76)	4.03 (0.72)	U = 873.0	3.70 (0.84)	3.66 (0.70)	U = 902.5	3.99 (0.65)	3.93 (0.57)	U = 891.5
11 Synthesize information (SimpleMind)	4.03 (0.67)	4.12 (0.66)	U = 969.5	4.02 (0.71)	4.06 (0.61)	U = 1002.5	3.85 (0.76)	4.01 (0.60)	U = 885.0	4.06 (0.77)	4.11 (0.70)	U = 1031.5	3.68 (0.85)	3.74 (0.67)	U = 999.5	3.95 (0.66)	4.04 (0.57)	U = 921.0
12 Locate a geographical area (Google Earth)	3.84 (0.73)	4.33 (0.44)	t = 3.993[b]	3.77 (0.72)	4.37 (0.45)	t = 4.901[b]	3.70 (0.77)	4.15 (0.56)	t = 3.270[b]	3.77 (0.77)	4.49 (0.46)	t = 5.580[b]	3.43 (0.81)	4.06 (0.67)	t = 4.269[b]	3.73 (0.67)	4.30 (0.40)	t = 5.071[b]
13 Trace a route on a map (Google Maps)	3.95 (0.67)	4.26 (0.63)	t = 2.223[a]	3.92 (0.69)	4.26 (0.62)	t = 2.419[a]	3.84 (0.75)	4.00 (0.65)	t = 1.050	3.93 (0.74)	4.37 (0.68)	t = 2.937[b]	3.58 (0.80)	3.93 (0.78)	t = 2.069[a]	3.87 (0.63)	4.19 (0.59)	t = 2.442[a]
Content Learning tool																		
14 Acquire new vocabulary (Smarty Pants school)	4.03 (0.74)	4.10 (0.43)	t = 0.465	4.02 (0.74)	4.06 (0.54)	t = 0.282	3.85 (0.75)	4.01 (0.65)	t = 1.060	4.05 (0.81)	4.12 (0.57)	t = 0.429	3.68 (0.84)	3.72 (0.74)	t = 0.185	3.95 (0.69)	4.03 (0.48)	t = 0.548
15 Reinforce spelling (Smarty Pants School)	4.00 (0.68)	4.15 (0.64)	t = 1.036	3.95 (0.70)	4.20 (0.63)	t = 1.720	3.83 (0.72)	4.03 (0.72)	t = 1.322	3.98 (0.77)	4.28 (0.66)	t = 1.972[a]	3.67 (0.87)	3.74 (0.66)	t = 0.418	3.91 (0.65)	4.11 (0.58)	t = 1.518
16 Improve phonetics (Mr Phonics)	4.05 (0.69)	4.03 (0.40)	U = 524.0	4.04 (0.70)	3.96 (0.53)	U = 459.0	3.92 (0.73)	3.69 (0.67)	U = 443.5	4.07 (0.77)	4.06 (0.53)	U = 509.0	3.70 (0.82)	3.63 (0.71)	U = 525.5	3.98 (0.66)	3.92 (0.46)	U = 470.5
17 Solve math quiz (Pop Maths)	3.97 (0.75)	4.14 (0.57)	t = 1.317	3.93 (0.76)	4.12 (0.59)	t = 1.425	3.89 (0.76)	3.89 (0.69)	t = 0.000	4.00 (0.85)	4.14 (0.63)	t = 0.994	3.60 (0.89)	3.78 (0.72)	t = 1.142	3.91 (0.71)	4.04 (0.54)	t = 1.130
18 Solve math tasks (Bubbling Math)	4.00 (0.71)	4.14 (0.59)	t = 1.086	3.99 (0.71)	4.09 (0.65)	t = 0.679	3.83 (0.77)	3.99 (0.64)	t = 1.122	4.03 (0.82)	4.14 (0.63)	t = 0.718	3.67 (0.86)	3.73 (0.73)	t = 0.385	3.93 (0.68)	4.05 (0.56)	t = 0.927
19 Improve numeracy (Connect the dots)	4.01 (0.75)	4.10 (0.56)	t = 0.628	4.04 (0.71)	4.02 (0.66)	t = −0.117	3.90 (0.77)	3.88 (0.67)	t = −0.176	4.16 (0.81)	3.97 (0.67)	t = −1.290	3.70 (0.86)	3.69 (0.76)	t = −0.041	3.99 (0.69)	3.96 (0.57)	t = −0.194
20 Assess the work done (Cut the Rope)	4.08 (0.69)	3.98 (0.61)	t = −0.754	4.07 (0.71)	3.94 (0.63)	t = −0.896	3.84 (0.75)	4.01 (0.63)	t = 1.081	4.09 (0.78)	4.01 (0.68)	t = −0.353	3.71 (0.87)	3.65 (0.65)	t = −0.393	3.99 (0.67)	3.94 (0.55)	t = −0.350

[a] $p < 0.05$.
[b] $p < 0.01$.

technology in classrooms. Users of Practicing writing skills App believe that mobile learning contributes to creating new ways to learning ($t = 2.140$) and increasing learning engagement ($t = 2.419$), autonomous learning ($t = 3.538$), and access to information ($t = 2.032$). In addition, users of the Apply math and literacy skills App think that mobile technology impacts positively on learning engagement ($t = 1.892$), and users of the Rehearse reading skills App perceive that mobile learning impacts positively on autonomous learning ($U = 628.0$).

In relation to Information Management tools, only teachers' users of three Apps (Search information, Locate a geographical area, and Trace a route on a map) perceive significantly higher the impact of mobile technology in creating new ways to learning ($t = 2.167$, $t = 3.993$, and $t = 2.223$, respectively), and increasing learning engagement ($t = 2.709$, $t = 4.901$, and $t = 2.419$, respectively), access to information ($t = 3.027$, $t = 5.580$, and $t = 2.937$, respectively), and collaborative learning ($t = 2.573$, $t = 4.269$, and $t = 2.069$, respectively). Only users of Locate a geographical area App believe that mobile learning impacts on autonomous learning ($t = 3.270$).

Finally, only users of the Content Learning tool, which Reinforces spelling, think that mobile learning increases access to information ($t = 1.972$).

5. Discussion

Findings provide significant information on the impact of learning that teachers perceive thanks to the use of mobile technology in the classroom, the frequency of use of relevant Apps in the classroom, and the differences in the perception of the impact on learning of mobile technology among users/non-users of Apps.

With regards to the first research question, the highest learning impacts of mobile technology are facilitating access to information, providing new ways to learn and increasing engagement in learning (Zhang, Wang et al., 2015). Findings are consistent with available literature about this topic in the sense that thanks to mobile technology, children have the opportunity to explore what they are learning from a variety of different perspectives (Boticki et al., 2015; Furió et al. 2015; Jahnke & Kumar, 2014; Murphy, 2011). Consequently, this facilitates access to details about a large amount of topics and supporting the emergence of relevant thoughts or ideas to contribute in class (Churchill & Wang, 2014; Furió et al. 2015; Jahnke & Kumar, 2014; Yang et al., 2015). Moreover, mobile technology is linked with the improvement of students' engagement to learning (Churchill & Wang, 2014; Gerger, 2014; Lu et al., 2014).

In addressing our second research question, the type of Apps most used is Content Learning Apps, and once more the type of Apps used most frequently is Content Learning Apps. Common features in these Apps are that they can usually be used independently by the students, they have instant feedback and assessment, and they are usable at a large range of educational levels. Since most studies are descriptive and qualitative in nature, this is an interesting fact to consider (Falloon, 2013).

Regarding our third research question, only users of a limited number of Apps perceived significantly higher most of the learning impacts of mobile technology. Most of these Apps are Learning Skills Apps and Informational Management Apps. This fact is consistent with the theoretical background; the quality of children's individual engagement is higher with Learning Skills Apps in contrast to their engagement with other Content Learning Apps (Kucirkova et al., 2014). The strong relationship between Learning Skills Apps and Informational Management Apps is that the learning process is changed by the role's transformation of the members involved in the learning process (Jahnke & Kumar, 2014). The authors argue that the teacher becomes a learning guide who helps students to adopt and connect reality to the learning content, and students become the constructors of their own knowledge. Thanks to mobile technology, students have nowadays the tools to produce their own learning and develop informational skills to succeed in the learning process.

The Apps that demonstrate the highest mobile technology impact are not the same as the Apps most used in the classroom. It seems clear that the instructional benefits of Apps used in our study do not include all the reasons that are prompting teachers to promote the use of tablets in classrooms. A proof that supports this consideration is that, whereas there are certain Apps used by more than 40% of classrooms, they do not seem to provide any instructional value either for teachers or users. This is particularly clear in three Apps, called Pop Maths, Bubbling Maths, and Connect the Dots. Teachers probably use Apps to improve learning specific math skills, not for general instructional benefits (Cayton-Hodges et al., 2015).

This study has two limitations. First, although types of learning impacts and types of Apps' were well-informed by literature, they encompass a limited number of categories. Further studies could include new categories not considered in this study and, for this reason, findings could change. Second, despite the fact that this work provides interesting data about these emergent research topics, the sample is not large enough and representative of the population and, consequently, conclusions need be corroborated by conducting new researches.

6. Conclusion

This study is directed to deepen our knowledge about what is the learning impact of mobile technology integration in primary education classrooms, and its relation with Apps' use. Three different conclusions could be taken into account.

Firstly, it seems obvious that Apps that better capture the educational affordances provided by mobile technology are as those that significantly impact on learning (Zhang, Wang et al., 2015). Affordances of mobile technology are defined as the attributes of this technology which provide potential for learning, and this potential provided by the affordances influences the learner progress towards the task goal (Churchill & Wang, 2014). Some relevant affordances of mobile technology reflected in these Apps: (1) portability, as handhelds can be taken to different locations; (2) interactivity, as handhelds can be used to interact with technology; (3) context sensitivity, as handhelds can be used to gather real or simulated data; (4) connectivity, as handhelds enable connection to data collection devices, other handhelds, and to a network; (5) individuality, as handhelds can provide scaffolding to the learners (Churchill & Wang, 2014); and (6) social media, which allow the creation and exchange of user-generated content (Zhang, Gao et al., 2015).

Secondly, findings also make clear that teachers use a large number of Apps, some of them used frequently in the classroom, that not produce a general learning impact. In fact, a broad set of these Apps are content learning tools. It seems clear that when teachers decide to use Apps in mobile technology, they have in mind other types of learning impacts, such as learning specific content.

Finally, the comprehensive conclusion is that, from an educational perspective, mobile technology cannot be seen as a single and homogeneous technology, but rather as a set of technological devices that supports a large amount of Apps. For this reason, it is important not only to pay attention to mobile technology in general, but also to consider the design and content of Apps in order to clarify what instructional benefits the combination of mobile technology and Apps actually give (Falloon, 2013).

In the interests of greater depth and detail, researchers should perhaps elaborate on these three possible research directions:

Apps' use in particular curriculum areas, in specific educational concepts, and in factors that influence the use of Apps in classrooms.

Annex 1

Learning skills tool

01 Berenstain Bears Lite: This interactive book App allows children to explore pictures, learn new vocabulary, listen to the story and personalize the story by recording their own narration.

02 Magnet ABC: This App allows users to write with the Magnetic Alphabet. It is an infinite source of fun and a great way to stimulate users' imagination and creativity.

03 Talking Tom and Ben News: In this App users' voices can be recorded to create the news by placing their own video or photo on the TV screen.

04 Pirate Treasure Hunt: In this App, the user needs to apply math and literacy skills in an ingenious way in order to solve the clues, and find the hidden treasure.

05 Gingerbread maker: With this App, kids can become creative chefs and create incredible Gingerbread cookies.

06 Doodle Buddy: This App allows the user to finger paint with lots of colours and drop in playful stamps.

07 PlayArt: This App introduces users to the world of art. The users will be able to play, learn and create their own masterpiece with elements taken from famous painters' works.

Informational management tool

08 Google Search: This App allows users to find everything from nearby restaurants to the calories in an apple.

09 Times To Go: This App is an exact digital replica of the Gainesville Times, and allows users to know the news from the daily newspaper.

10 Sticky Icky Bathtime: This is an intuition App that helps the child to build confidence while learning manipulation activities with Sticky Icky.

11 SimpleMind: This App is a mind mapping tool that turns the device into a brainstorming, idea collection and thought structuring device and helps the user to synthesize information.

12 Google Earth: This App allows the users to fly around the planet with a swipe of their finger. Moreover, it allows the user to explore distant lands and search for places.

13 Google Maps: This App makes navigating the world faster and easier. The user will find places in town and the information to get there.

Content learning tool

14 15 Smarty Pants School: This App enables teachers to introduce, teach, and reinforce a wide variety of pre-reading and reading skills games to their children.

16 Mr. Phonics: This App presents a comprehensive collection of over 150 literacy videos for learning to read English, using the synthetic phonics.

17 Pop Maths: This App allows children of all ages to practice basic math in a funny way.

18 Bubbling Math: This App allows children to do math tasks. The user can practice all the elementary math operations by problem solving.

19 Connect the dots: This App makes learning the alphabet, numbers and words fun for kids.

20 Cut the Rope: In this physics-based game, the user must collect gold stars, discover hidden prizes and unlock exciting new levels by evaluating the task done.

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