EAI Endorsed Transactions
on e-Learning

Research Article ICST.ORG

Adoption Concerns for the Deployment of Interactive Public Displays at Schools

José Alberto Lencastre[1,*], Clara Coutinho[2], João Casal[3], and Rui José[4]

[1,2]Istitute of Education, University of Minho, Campus de Gualtar, 4710-057 Braga, Portugal
[3,4]Centro Algoritmi, University of Minho, Campus de Azurém, 4800-058 Guimarães, Portugal

Abstract

JuxtaLearn is a research project focused on 'performance' as a means of provoking students' understanding of science and technology through the creation and sharing of educational videos. As the videos will be shared in public displays, the Portuguese research team developed three workshops with twelve teachers from a Portuguese Secondary School representing different school departments and sharing organizational responsibilities. The aim was to generate scenarios of possible features and interaction for the curricular integration of the technological device. Our findings suggest that teachers are not motivated to use, on their own, technologies in the classroom, but receptive to new and challenging technologies when properly stimulated. They were able to generate scenarios that take advantage of the possibilities offered by digital public displays to stimulate learning processes. However, there are pedagogical, organizational and ethical concerns in the management and control of content that need to be resolved before they feel confortable to deal with change and technological innovation.

Keywords: Participatory design; development research; public display system; technology-enhanced learning.
Received on 30 July 2014, accepted on 24 September 2014, published on 2 December 2014

doi: 10.4108/el.1.4.e6

1. Introduction

The impact of Information and Communication Technology (ICT) in our global societies held the development of different policies regarding the introduction of ICT in schools and educational systems. There is a strong belief that ICT can be the driving force in a change of paradigm in education [1, 2], and so, following other European countries, Portuguese educational policies enhanced the integration of ICT in non superior schools. At the same time, huge investments were made in equipping schools with computers and Internet access as well as in the training of teachers for the Learning Society [3]. However, as stated by Hargreaves [4], a profound change in the traditional standardized curricula that is the same for all students and centred in the approval in final examinations is needed, including the adoption of new standards for assessing learning that should focus in the development of competencies that prepare students to deal with change and innovation and where the use of ICT is a pre-requisite [5].

In this context, being prepared to use technology and knowing how that technology can support student learning have become integral skills in every teacher's professional repertoire [6, 7, 8]. Interactive computer simulations, digital and open educational resources, and sophisticated data-gathering and analysis tools are only a few of the resources that enable teachers to provide previously unimaginable opportunities for conceptual understanding [9].

However, recent researches show that educational practices have remained almost unchanged: teachers continue to teach in traditional ways [10] and when they use technologies it is not for enriching technology-supported learning opportunities for their students. The greatest futile public assumption was that making computers available to educators would automatically result in their implementation in the classrooms [11, 12]. In fact, and according to Coutinho [3], the innovative nature of pedagogical practices using ICT, if not accompanied by training that can lead to practical and reflexive activities on teachers, can't, by itself, bring great changes in the teaching practices of teachers.

In order to generate scenarios of possible features and interactions for the curricular integration of a public display in a Portuguese Secondary School, twelve teachers with supervision responsibilities were involved in three participatory design workshops.

*Corresponding author. Email: jlencastre@ie.uminho.pt

The purpose of the 1st workshop was to present the participatory design model and the goals of JuxtaLearn project. We also presented an overview of digital public displays use. Several scenarios of known public displays usage were launched and teachers were challenged to describe possible scenarios with the digital displays chosen and the features that they considered most relevant. Building upon the results of this 1st workshop, the 2nd workshop aimed to develop paper prototypes with features and interaction techniques with the display. Teachers were invited to write a story of interaction using the prototypes designed. The 3rd workshop was focused on the discussion of a high fidelity prototype designed from the results of the previous two workshops. In small groups, the teachers discussed the possible scenarios' of use, and also how to engage students to start interacting with the system. Data were collected from video records and questionnaires delivered at the end of the sessions. Content analysis revealed the emergence of four main categories that were considered for data analysis: (1) Motivation for adoption, (2) Pedagogical Practices, (3) Organizational concerns, and (4) Ethics.

2. Related work

The integration of digital technology into formal and informal learning environments has been a hot topic of research for more than 20 years. Research has shown that digital technologies can be effective in positively impacting student's motivation, engagement and interest in learning [13]. Akhras [14] studies have also shown that incorporating interactive technology has positive effects on student performance. While many students already have web-capable smartphones [15], Sun [16] observed they no longer seem them as a novelty. However, incorporating them into class is still a potentially effective way to increase student attention and improve their learning skills. Swan, van't Hooft, Kratcoski, & Unger [17] reported that students found that using mobile devices is fun and can make schoolwork easier. Moreover, as online communication and digital technologies are increasingly a ubiquitous part of children's daily lives, there are increasingly more opportunities to create solutions that take advantage of the complexity and diversity of the involving eco-system.

Large public displays in the communal space of the schools, i.e. outside the classroom, have also been explored to promote informal learning and student engagement. The Dynamo display system [18] is a large multi-user interactive display for sharing, exchanging and showing multimedia content in a communal room of a high school. It provides a GUI like interface accessible from various interaction points (wireless mice and keyboards) so that multiple users can interact with it at the same time. Students used Dynamo to display and exchange photos, video and music; to create a pool of public media that anyone could use; to stage performances to the audience in the communal room; to post notices to other users; to leave content as gifts to specific people; and to engage in group discussions and interactions. The use of large displays in the communal space of a secondary school and a University has been addressed in the Instant Places project [19, 20]. This system allows users to contribute to the content that is displayed by specifying keywords on the Bluetooth names of their mobile phones. Studies have explored how open content publication impacted the power relations at schools.

Videos can also play a worthy role in the learning process. The benefits of digital video as a constructivist learning and pedagogical tool are widely emphasized in literature, ranging from motivational and learning-to-learn benefits to providing strategies of collaborative knowledge building and effective video-based learning. The versatility of this multimedia content, regarding its use in learning activities, has been highlighted by Chambel & Guimarães [21], namely through its potential for the integration with other media and the active role of students in the learning process. A video-based story is employed by Hmelo-Silver [22] as the context of a problem based learning, where that multimedia content is pointed out as a support for comprehension. Studies by Light & Polin [23] indicated the use of YouTube and similar websites as exciting tools to be used on classrooms. The same authors also mentioned that the video production made by students is a form of reflecting knowledge built. Koumi [24] states that video has the ability of stimulating the will to learn and inciting viewers to act, changing habits and attitudes towards learning. In this line of work, Casal [25] made a pedagogical intervention using video production as a process of reflexive learning with Portuguese secondary school students and verified its benefits in the promotion of motivation and autonomy in learning. Barthel, Ainsworth, & Sharples [26] proposed the use of shared multi-path video as a form of promoting collaborative and informal learning, and envisioned that the full potential of ubiquitous video platforms may follow the growing of novel applications and user interfaces such as tablet computers and smartphones with recording and sharing features.

In our work, video creations are the central element of a learning process designed to help students overcome specific learning barriers. However, videos are not per se the main outcome of that process. The aim is to promote the reflection and collaborative dialog that should emerge from first creating the video and then sharing it on a dedicated web space and on the public displays at schools. In a previous work, we have already presented the conceptual prototype of a display system for video sharing at schools that emerged from these same workshops [27]. In this specific work, we abstract away from the specific features of the display system, and focus instead on the key organizational and pedagogical issues emerging from the process of integrating and exploring the potential of these technological devices in public spaces of basic and secondary schools.

3. Method

Our initial explorations involved a participatory design approach where we invited 12 teachers to take part on a set of three design workshops. Participatory design is an approach to design that involves key stakeholders as co-designers on the design team itself [28, 29] in order to understand what, in their point of view, is appropriate or inappropriate, what is enjoyable or unpleasant, useful or useless, and the reason to this opinions. The aim of these workshops was to provide the research team with knowledge about the specificity of the social context where the displays will be deployed, and gather insights into the best way to frame video sharing in the school environment.

3.1. Data collection and analysis

All sessions were videotaped and an online questionnaire was made available after each session, to be filled later. This allowed the teachers to reflect on the issues presented and discussed. The data from each questionnaire were analysed between sessions in order to foster the next session. In the end, data gathered from the video records and from the answers to the open-ended questions (of the three questionnaires) were coded in an inductive approach for qualitative data analysis [30].

The first step of the analysis was a "brief reading" of the transcribed text for general evaluation [30]. Then, the material exploration began through MAXQDA software, transforming raw data by clipping, sorting and aggregation, thereby establishing categories according to the most common topics found. In an attempt to assure the validity of the coding process, initially, a first coder categorized the corpus. 255 units were identified, and 19 categories emerged from data. For each category, a list of indicators was defined to help a more precise description of each registration unit of analysis. The category system was discussed inside the research team in order to ensure validity, and some categories and indicators were rearranged into a final category grid [31]. Four categories were then systematized and considered for the analysis: (1) Motivation for adoption, (2) Pedagogical Practices, (3) Organizational, (4) Ethics.

In order to guarantee the reliability of the encoding process two independent coders categorized all the information according to the list of dimensions [31]. The two researchers discussed previously the conceptual categories and rehearsal some examples of encoding different types of evidences (thematic units). After this initial preparation, the two coders categorized the corpus independently and inter-rater percents of agreement were computed and a value of 79% of consensus was obtained, revealing a satisfactory level of reliability of the encoding process.

4. Findings

This section presents the key ideas that emerged from the data analysis on each of the four categories considered for analysis.

4.1. Motivation for adoption

An important element within our project is the motivation to adopt the system. Although the idea to place the display in the school resulted mainly from the project, it was positively received by teachers. Even though they did not immediately see how the display could be useful to them, they seemed to have the perception that students would accept the system very positively. On the 3rd questionnaire a teacher wrote: *"The attractiveness for new technologies, and the away that this school faces new projects, will allow the success of this initiative".* On the same questionnaire another teacher also wrote: *"Because students have alternatives to school in the field of leisure time (unlike what happened a few years ago) the use of the display can become a way to capture their attention and refocus their activity in school"*.

Overall, teachers also seemed to perceive the display deployment as being positive to the school itself, but the motivations for adoption could mostly be described as variations of a vague sense of coolness. A teacher refers that *"Innovative technologies contribute to increase the image of the school as dynamic and modern and therefore this public display would be an interesting element for enriching that image"*.

This coolness factor is obviously positive because it creates a window of opportunity for engaging with the stakeholders at the school and get support for the system deployment. However, it also encompasses one of the major challenges for these technologies, which is to go beyond the novelty effect.

4.2. Pedagogical practices

A key goal for this study was also to understand how the video creation and sharing could be integrated into the teacher's pedagogical practices. Teachers believed that the student's attention holds up when using digital interaction, which in itself constitutes a student's motivation to content. One teacher referred that the display will be an opportunity to show what goes on in the classroom, like an extension of the classroom: *"It's almost like an exhibition where show what we're doing (...) and usually students enjoy to see their work exposed and viewed by colleagues and by the educational community in general"* [PROF2 (13:41)].

Three subcategories emerged in this topic: i) Fairness of pedagogical practices, ii) Students' responsibility and autonomy, and iii) Students' engagement.

i. Fairness of pedagogical practices

One of the teachers' concerns is about the fairness of pedagogical practices. If the pedagogical video is something that all students 'have to do' this could be a problem, because the teacher has the responsibility to provide appropriate training and equipment (video cameras) for all. On the 2nd questionnaire another teacher wrote, *"(…) the school is not prepared for that. On the other hand, if it is not mandatory, only a few will be involved, only the most motivated ones (with the proper skills or motivations to develop those skills)".*

ii. Students' responsibility and autonomy

One way to engage all the students is set them to manage the system. According to one teacher this could be a good opportunity because *"experience tells us that when we give responsibilities to the students (and they realize the limits), they succeed"* [Prof2 (10:20]. More complex is the process of managing the content. This process is not common ground between teachers: *"The videos must be made by the students, but the scientific guarantee has to be given by the teacher"* [Prof10 (10:09)] or *"Validate the content should be the responsibility of the disciplinary groups"* [Prof10 (24:27)]. However, one teacher referred that in the video design process the scientificity can be obtained. In his own words: *"(...) when we ask a student to do a work and we follow him in the development process, in some way we are already guiding him in order to have an adequate scientific product"* [Prof4 (13:35)].

iii. Students' engagement

During the session we asked the group if they could create educational videos that were also playful. We gave an example of *Parkour* video associated with laws of physics. This suggestion was welcomed [Prof1 (27:54)].

We put into discussion some ways of initiate/stimulate the interaction with the digital display. One teacher presented the idea of designing quizzes: *"putting quizzes about the video content could improve student's motivation to interact with the display"*. Another teacher referred that *"promoting intra and inter class competitions could be a valuable initiative"*. It was discussed the possibility to organize a contest for the best video from different school subjects in order to popularize the creation of content and ensure that almost everyone has their contents in the system.

4.3. Organizational concerns

The introduction of a high visibility digital artefact, such as a public display, in the school setting will necessary have to consider a very broad range of organizational issues. On one hand, the system design will have to consider the multiple organizational sensitivities involved. On the other hand, the organization should also consider some potentially disruptive role that the technology may have in regard to existing practices and power relationships.

Teachers establish three groups of interest: *"there is one regulated by the school board in order to use the display to provide institutional information (classes, school rules, schedules, and so on); from the teachers point of view there is a pedagogical interest in using the display as a didactic tool; and there is obviously the students curiosities, with a more ludic interest"* [Prof1 (01:50)].

Because in this first stage we work with the school board and with teachers, the first two approaches are the most important to match our focus: how the system should be used and who will manage it.

Teachers and the school board felt that will be fairly easy to implement the project. Teachers said that the school is very dynamic and proactive. However, to put this kind of projects into practice is indispensable the collaboration of a lot of teachers who are increasingly overwhelmed with work. The teachers talked about workload: *"when it assigns a group too small, does not work because this group does not have enough time. But if you are going to allocate a teacher or two ... never again, the work will never be complete"* [Prof1 (3:03)]. In other words, the work is too much for just one element. On the other hand, if there is too many people involved could be difficult to manage the system.

Three subcategories emerged in this topic: i) Community members, ii) Identity / membership, and iii) Space.

i. Community members

Students are not just seen as individuals but also as members of formal communities with strong impact in interaction patterns and organisational models, e.g. class, school year. The public display can stimulate the perception of belonging to a community. One teacher said [Prof2 (6:44)]: "*I think the community spirit is more important than the individual*" (many teachers agreed). It is the embrace of a new way to communicate with others, in which all actors are members of the community and it makes the community to pay more attention to the content. In this perspective, all themes are transversal. For example, a student of literatures sees a good post on electronics and feels motivated to discuss it with colleagues: "*Back in my school the personnel from electronics made a spectacular thing! I have to read the book Lusíadas while others do an extraordinary electronic work…*" [Prof7 (14:26)]. This strengthening of social ties allows "*each student to belong to more than one group*" [Prof1 (00:30)], what is good for the school environment.

ii. Identity / membership

One of the issues that took us considerable time was the system authentication: how to authenticate? Here emerged two related concerns: (i) the system registration and (ii) the authentication to comment on the videos.

For the first issue it was agreed that everyone must have a previous registration. The teachers must register along the school board, and the students with their tutor. The idea of using the student identity number to authenticate in the system emerged, because some teachers support the belief that the students use unrecognizable names in the Web devices. However, it was not completely clear whether the registration should be subject to a validation process (as someone suggested) or if the fact of being a school member is enough to have the right to be registered: *"But not all students can be enrolled… it could have a manager or a group of student, instead"* [Prof5 (3:00)].

What was clearly defined is that everyone must use a genuine email account. Teachers and staff have the official and internal ones. Students can use the email account provided in the school official documents. For the school board it is very important to have all the students identified. In order to allow someone to use the system, it must be unquestionable that the person is who he claims to be. If they are registered users, it is possible to be identified and the students will be more careful with what they will say.

It was encouraged the idea that the system should have a good set of applications designed to act as an incentive to its good use. On the other hand, the schools' webpage, for example, could have a document with a set of guidelines and rules of good practices.

iii. Space

An important issue was where to place the display. When questioned about the best space to put the display the school board and the teachers replied unanimously: *"The screen should stay in the student's zone or in the school's entrance (…) but it's better in the student's lounge because the entrance is too noisy with everyone moving from one place to another"* [Prof5 (8:34)] and *"should be in the student's room … so that everyone can see the information at any time"* [Prof7 (8:42)].

4.4. Ethics

Ethics has a different understanding for each one of us. Sometimes the concept is slightly diffuse and depends on the context. Schools are a very special environment, with particular rules, statutes, rights and duties of those who live there. So, when we talk about public displays in schools it is not peaceful to say that the *content is only seen by those who want to*. This could be assumed about a display in a public space but not in the school context, because the children are not always with an adult responsible for explaining or preventing the child to see that particular content: "*it is the school board obligation to ensure that no susceptibilities is hurt*" [Prof3 (21:45); Prof8 (22:17)]. It must be cautious with the contents. From the teacher's point of view, a lack of control could generate the use of inappropriate language and deviant behaviours. This could be seen as an organizational concern but is also an ethic matter from the teachers' point of view.

Three subcategories emerged in this topic: Equal access to the display system, Protection of privacy, and Protecting minority groups and facilitating diversity of opinions.

i. Equal access to the display system

The most debated ethical issue was related to equal access to the display system. A teacher said: *"My concern is with the fact that not all students have computers or smartphones to interact with the display. (...) Why not use touchscreens so that all students can use the system?"* [Prof4 (21:17)]. This was a very appreciated proposal. However, teachers emphasized that if the required touchscreen doesn't have the entire smartphone features it will be useless.

One teacher questioned all the colleagues about the use of smartphones in the school, warning to a legal restriction: *"But if it is forbidden to bring the smartphones to school, isn't it?"* [Prof6 (25:40)]. Other question under discussion was the possibility of the display to provide multiple events simultaneously. For example, a student might be seeing the bus schedule and another colleague may be seeing school sports content.

ii. Protection of privacy

Ethical issues are increasingly diluted with the use and abuse of sharing almost everything online. So, teachers were very concerned with the protection of privacy. Very significant segments of the school community are young children and "*it is not easy (or permitted) to advertise images without direct authorization from parents or legal guardians*" [Prof8 (22:17)]. Teachers emphasized the need of a disclaimer in the school's website warning this.

The possibility to comment on and vote the videos has also a lot of parallel issues to be considered. Many teachers fear that allowing anyone to comment on the videos could lead to language abuses that would compromise the system. On the other hand, the possibility to vote (positively with a 'like' or negatively with a 'dislike') could create frictions between school groups.

iii. Protecting minority groups and facilitating diversity of opinions

Another ethical issue has to do with the need to protect minority groups and facilitate a diversity of opinions. Teachers pointed out the need to explore mechanisms to protect the diversity of the schools' populations and try to promote the expression of different opinions, topics, likes and dislikes. It was, once again, encouraged the idea of having a document with a set of guidelines and rules of good practices. One teacher suggested, *"the possibility of ban the students that do not follow the rules by cancelling the login"*. Another teacher pointed out an alternative by stating that the system could support only *"positive comments, the equivalent of a 'like' in Facebook"*.

5. CONCLUSION

Recent researches show that teachers continue to teach in traditional ways, without taking advantage of new technologies. In the scope of JuxtaLearn project, one of our goals is to involve teachers in the research process in order to motivate them to integrate technology in the curriculum, enriching learning opportunities for their students.

In this paper we describe a study where the aim was to design scenarios for the curricular integration of interactive digital displays in a Portuguese secondary school. In terms of the process implementation a number of suggestions and ideas emerged from data collected in the three sessions with schoolteachers.

First, teachers do not have an intrinsic motivation to use technology, because they cannot see any added value for them. It means that before the system is actually deployed and available for appropriation, it will be extremely difficult for the teachers to identify clear value propositions that can realistically match the possible system features.

Second, teachers think that creating videos and share them on public display can be an interesting dimension to develop, and see advantages in engaging and empowering students in this process. All teachers mentioned that the pedagogical ad value would certainly engage students in something they like: the interactive technology.

Third, the most fundamental element in regard to organizational issues seems to be the level of institutional influence that is associated with the display. The installation of the display in an everyday communal space is necessarily perceived as being endorsed by the school board. Therefore, there is also a common perception that the teachers should control or endorse content shown on that display.

Fourth, in the school context, privacy is an ethic issue always present. The teachers defend that it is an obligation to ensure that the display system is appropriately used. Also pointed out the need to explore mechanisms to promote equal access to the display system to all students, protecting minority groups and promote the expression of different opinions.

It is also believed that this research would provide useful information for researchers in the field of ICT education. In future research it is intended to: study the process to generate students' curiosity about the interactive public displays; investigate the acceptability of the use of video in the classroom by teachers and students; understand of teachers' pedagogical relevance of the video creation process; and check if the video creation process, including reflection on how to represent content in a creative way, contributes to understand tricky pedagogical content.

Acknowledgements.

The research leading to these results has received funding from the European Community's Seventh Framework Programme (FP7/2007-2013) under grant agreement no. 317964 JUXTALEARN. We would also like to sincerely thank all the teachers from Escola Secundária de Alberto Sampaio (Portugal) that agreed to participate in the participatory design workshops.

References

[1] Punie, Y. C., & Cabrera, M. (2006). The Future of ICT and Learning in the Knowledge Society. *Report on a Joint DG JRC-DG EAC Workshop, Seville, October 2006*. Institute For Prospective Technological Studies. EU: Joint Research Center.

[2] Coutinho, C. P.; Alves, M. (2010). Educação e sociedade da aprendizagem: um olhar sobre o potencial educativo da Internet. *Revista de Formación e Innovación Educativa Universitaria*, Vol 3, Nº 4, 206-225. ISSN: 1989-0257. Disponível em http://webs.uvigo.es/refiedu/ e em http://hdl.handle.net/1822/11229.

[3] Coutinho, C. P. (2009). Challenges for Teacher Education in the Learning Society: Case Studies of Promising Practice. In H. H. Yang & S. H. Yuen (eds.), *Handbook of Research and Practices in E-Learning: Issues and Trends*. Chapter 23 (pp. 385-401). Hershey, New York: Information Science Reference - IGI Global. ISBN 978-1-60566-789-8. Disponível em http://hdl.handle.net/1822/9981.

[4] Hargreaves, A. (2003). *O ensino na sociedade do conhecimento: A educação na era da insegurança*. Porto: Porto Editora.

[5] NESTA (2007). *Innovation in response to social challenges*. London: NESTA

[6] Coutinho, C. P. (2013). Assessing Learning with Web.2.0 Tools: Lessons Learned from a Portuguese Initiative. In M. Thomas (org.). *Pedagogical Considerations and Opportunities for Teaching and Learning on the Web*. Chapter 2, pp. 17-40, Advances in Educational Technologies and Instructional Design (AETID) Book Series, IGI Global. Disponível em http://www.igi-global.com/book/pedagogical-considerations-opportunities-teaching-learning/77382

[7] Coutinho, C. P.; Bottentuit Junior, J. B. (2009). Literacy 2.0: Preparing Digitally Wise Teachers. In A. Klucznick-Toro et al.(orgs). *Higher Education, Partnership and Innovation (IHEPI 2009)*. Budapeste: PublikonPublishers/IDResearch, Lda. pp. 253-261. ISBN:

978-963-88332-5-9. Disponível em http://hdl.handle.net/1822/9978

[8] Coutinho, C. P. & Lisboa, E. (2011). Sociedade da Informação, Conhecimento e Aprendizagem Desafios para a Educação no Século XXI. *Revista de Educação, Vol. XVIII, nº 1, 2011*, pp. 5-22. Disponível em http://hdl.handle.net/1822/14854.

[9] UNESCO (2008). *ICT competency standards for teachers*. Paris: United Nations Educational, Scientific and Cultural Organization. Retrieved from http://unesdoc.unesco.org/images/0015/001562/156209E.pdf

[10] Fernandes, R. (2006). *Atitudes dos professores face às TIC e a sua utilização ao nível do ensino secundário*. Master dissertation. Lisbon: University of Lisbon.

[11] Coutinho, C. P. (2012). Developing Pre-Service Teachers' Competencies In Using Technologies In The Classroom: An Example From Portugal. In C. D. Maddux, & D. Gibson (eds.). *Research Highlights in Technology and Teacher Education 2012.* (pp. 91-101). Association for Advancement for Technology and Teacher Education. ISBN 1-8800-9496-7.

[12] Piano, A. R. (2007). *Vinte anos de investigação sobre Tecnologias Educativas em Portugal: uma sistematização da investigação desenvolvida entre 1985 e 2005*. Master Dissertation (unpublished). Lisboa: Universidade de Lisboa.

[13] Reiners, P., Renner, K., & Schreiber, J. (2005). *The Effect of Technology Integration on Student Motivation, Engagement and Interest*, http://kr012.k12.sd.us/Portfolio/Group Research Paper.pdf.

[14] Akhras, C. (2012). Interactive Technology: Enhancing Business Students' Content Literacy, (Original Research Article). *Procedia - Soc. Behav. Sci., 83*, 332–336 (2013).

[15] King, L. (2012). *The Teaching Revolution*, http://www.taolearn.com/articles/article62.pdf.

[16] Sun, J. (2014). Influence of polling technologies on student engagement: An analysis of student motivation, academic performance, and brainwave data, Original Research Article. *Comput. Educ*. 72, 80–89.

[17] Swan, K., Hooft, N. van't, Kratcoski, A., & Unger, D. (2005). Uses and effects of mobile computing devices in K-8 classrooms. *J. Res. Technol. Educ*. 38, 99–113.

[18] Brignull, H., Izadi, S., Fitzpatrick, G., Rogers, Y., & Rodden, T. (2004). The introduction of a shared interactive surface into a communal space. *Proceedings of the 2004 ACM conference on Computer supported cooperative work - CSCW '04* (p. 49). New York: ACM Press.

[19] José, R., Otero, N., Izadi, S., & Harper, R. (200(). Instant Places: Using Bluetooth for Situated Interaction in Public Displays. *IEEE Pervasive Comput. 7*, 52–57 (2008).

[20] Otero, N., José, R., & Silva, B. (2012). Interactive Public Digital Displays: Investigating Its Use in a High School Context. In *Proceedings of the Workshop on SOcial and MObile COmputing for Collaborative Environments (SOMOCO)*. LNCS 7567, p. 617.

[21] Chambel, T., & Guimarães, N. (2001). Learning with Video in Hypermedia. , Lisbon (2001). Hmelo-Silver, C.E.: Problem-Based Learning: What and How Do Students Learn? *Educ. Psychol. Rev. 16*, 235–266.

[22] Hmelo-Silver, C.E.: Problem-Based Learning: What and How Do Students Learn? *Educ. Psychol. Rev*. 16, 235–266 (2004).

[23] Light, D., & Polin, D.K. (2010). *Integrating Web 2.0 tools into the classroom: Changing the culture of learning*. New York.

[24] Koumi, J. (2006). *Designing Video and Multimedia for Open and Flexible Learning*. Routledge - Taylor & Francis Group.

[25] Casal, J. (2013). Construtivismo tecnológico para promoção de motivação e autonomia na aprendizagem. *XII Congresso Internacional Galego-Português de Psicopedagogia*. Braga: Universidade do Minho.

[26] Barthel, R., Ainsworth, S., & Sharples, M. (1977). Collaborative knowledge building with shared video representations. *Int. J. Hum. Comput. Stud. 71*, 59–75 (2013).

[27] Otero, N., Alissandrakis, A., Müller, M., Milrad, M., Lencastre, J.A., Casal, J., & José, R. (2013). Promoting secondary school learners' curiosity towards science through digital public displays. *Proceedings of International Conference on Making Sense of Converging Media - AcademicMindTrek'13*, (pp. 204–210). New York: ACM Press.

[28] Schuler, D., & Namioka, A. (eds.) (1993). *Praticipatory Design: Principles and Practices*. New Jersey: Lawrence Erlbaum.

[29] Steen, M., Kuijt-Evers, L. & Klok, J. (2007). Early user involvement in research and design projects – A review of methods and practices. In *23rd EGOS Colloquium (European Group for Organizational Studies)* July 5–7, 2007, Vienna.

[30] Bardin, L. (2011). *Content Analysis*. Lisboa: Edições 70.

[31] Coutinho, C. (2013). *Research Methodologies in the Humanities and the Social Sciences*. 2nd edition. Coimbra: Almedina.