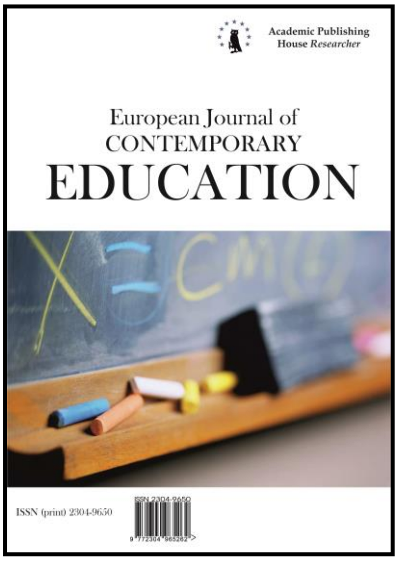
Published in the Slovak Republic
European Journal of Contemporary Education
ISSN 2304-9650
E-ISSN 2305-6746
2017, 6(3): 401-413
DOI: 10.13187/ejced.2017.3.401
www.ejournal1.com



mSciences: an Affinity Space for Science Teachers

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Abstract

The project 'Multimedia in science teaching: five years of research and teaching in Portugal' was successful in featuring the national research on multimedia in science education and in providing the community with a simple reference tool – a repository of open access scientific texts. The current work aims to describe the theoretical background that may allow creating and sustainably developing an online community on science teaching. The community should be capable of appropriating and generating scientific peer review and validation processes, which would allow reflections on teaching practices in science areas using information and communication technologies (ICT) and improvements from a participatory science perspective. Through an action-research process, the current platform is being adjusted in the sense of implementing strategies able to attract and engage an interested public and progressively to create a community of peers. The project is particularly relevant with respect to the gap between academic production and pedagogical practice and the avenues that it opens for comparing affinity spaces across different locations and domains of interest.

Keywords: Multimedia education; science teaching; community of practices; affinity spaces

1. Introduction

Learning, teaching, and communicating science very often implies the use of technology. During recent decades, researchers have tried to understand how people learn using information and communications technology (ICT). Several approaches to teaching have emerged from

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different theoretical perspectives, such as behaviourism, constructivism, and cognitivism (Pange et al., 2010).

Instead of considering the different learning theories as discordant, the attention should be directed to the role of the teacher in the selection and articulation of these theories with the pedagogical practice, placing the teachers as pedagogical engineers or designers, with the responsibility to plan classroom activities with the most effective approaches and technologies available (Hung, 2001).

This may seem easy, as the new generation of teachers is said to be increasingly knowledgeable about and skilled in the use of ICT. According to Martinovic and Zhang (2012), new teachers not only are willing to try different kinds of ICT, but they also seek opportunities to do so, with their students' interests as a priority. However, this is not always the case or one free from difficulties, as some problem areas have been detected. Hurdles include the lack of modelling of the pedagogical approaches of ICT; misconceptions about the use of some ICT; restricted access and comfort in the use of ICT among pre-service teachers; and the expectations of these future teachers regarding ICT learning and teaching opportunities (Martinovic, Zhang, 2012). Subject-specific pedagogical uses of technology are also difficult to provide, as there is a separation of content knowledge learning from educational methods in teacher training programs (Han et al., 2013). What thus can be done to persuade teachers to adopt multimedia in their teaching in a critical way, reflecting and sharing the results of their practices and commenting on and assessing their peers' practices?

In this paper, we aim to address the growing need of closing the gap between scholars and practitioners by describing the path that, through an action-research process, allowed us to develop an ongoing online project named mSciences. We will start by framing the reflection on the international policies for a knowledge-driven society that acknowledges the centrality of scientific literacy. This will lead us to the concept of communities of practices explored in Section 3, as an ideal model of horizontal sharing of knowledge. As communities of practice are organic and spontaneous, and, consequently, less suitable for top-down projects such as ours, the paper evolves into the analysis of the affordances of the affinity spaces in Section 4. Section 5 provides a brief description of the characteristics of the affinity space mSciences. The paper concludes with Section 6, presenting the significance of the present and future research on affinity spaces.

2. A knowledge-driven society

Policy actions suggested from the ET2020 Working Group on Schools Policy to improve Initial Teacher Education state the need to improve practice through links with research (Commission, 2015). In Europe, although the infrastructure and a solid research base exist, the potential of new technologies is not being achieved, as few information and communications technology-enabled learning innovations (ICT-ELI) are transmitted from research to educational practice (Brecko et al., 2014).

The Europe 2020 strategy recognized the need for a change in education to achieve new skills and competencies, thus establishing innovation as a key priority in several of its initiatives. This report, involving around three hundred stakeholders in the field of education, sets out several recommendations, including the need to exchange knowledge on the application of innovative ICT-dependent practices, as well as the promotion of research on the ICT-ELI, focused on learning advantages. It also encourages the participation of teachers in professional networks for the dissemination of pedagogical innovation (Brecko et al., 2014).

The gap between research and practice, which is more strongly felt by teachers than by school leaders or researchers, should be reduced (Vanderlinde, van Braak, 2010), therefore allowing science education research findings to be incorporated into teacher preparation, curriculum development, as in teaching and learning (Hazelkorn et al., 2015).

In fact, according to Reich, Gemino, and Sauer (2012), in an organization, high-quality results are not necessarily obtained with the most competent workers, but with elements that, besides being competent, are motivated for effective practices of knowledge and knowledge sharing. Only if knowledge becomes explicit in perceptible forms can it be internalized and applied by other individuals, who will use, extend, and reframe it in their own tacit knowledge (Nonaka, 1991).

To facilitate the sharing of knowledge and good practices, many have turned to information technology, but found that, despite its advantages, IT alone was not enough for this sharing to succeed (Brazelton, Gorry, 2003). Ipe (2003) asserted that the nature of knowledge, the motivation to share, the opportunities for sharing, and the culture of the work environment were the main factors that influenced the dynamics of knowledge sharing in an organization. Moreover, Tseng and Kuo (2014) stated that performance expectation and self-efficacy belief are relevant in knowledge-sharing between teachers.

Open access to publicly funded research results is one important mechanism that could decrease this gap and facilitate new research and innovation (Hazelkorn et al., 2015), as this open and easy access to scientific knowledge would allow for the wider sharing of knowledge (Communities, 2007). All this work, freely available, would also profit from the pronouncement of teachers, researchers, and experts on the science, technology, engineering, and mathematics (STEM) teaching practices (Paiva et al., 2015; 2016) because it would allow the establishment of genuine links between scientists and science educators in a two-way communication (Hazelkorn et al., 2015).

The project 'Multimedia in science teaching: five years of research and teaching in Portugal' was successful in analysing Portuguese research on multimedia in science education and, in addition, in making available a simple query tool associated with a repository of open-access scientific texts (Paiva et al. 2015; 2016). In theory, this query tool would allow access to the beneficial integrative knowledge about technology uses that is pedagogically appropriate and could work in subject specific contexts (Han et al., 2013), but the results of its use thus far have been discouraging.

The results of Kuo and Young (2008) evidenced that in fact people do not always behave consistently in knowledge sharing, confirming that to manage knowledge we also need to manage people. So, how can we drive researchers and teachers toward knowledge sharing to close this gap?

Brazelton and Gorry (2003) stated that there needs to be a common purpose to make people use the collaborative tools for knowledge sharing. Smith (2001), although referring to organizations, suggested the implementation of communities of practice—a community of elements involved in a collective learning process in a common domain (Wenger-Trayner, Wenger-Trayner, 2015). These communities could informally tie people who share expertise, thus enhancing learning and the dissemination of tacit and explicit knowledge (Smith, 2001). In the next section, we will precisely examine the concept of communities of practice.

3. Communities of practices

A community of practice can be seen as a simple social learning system that can achieve complexity by interrelating different communities of practice (Wenger, 2010). We must, however, use some caution, for all that glitters is not gold, and not everything that is referred as a community is a community of practice.

Naturally existing communities of practice (CoPs) are groups of people informally bound together through shared expertise and passion who engage in a process of collective learning, with or without an explicit agenda. Learning may not be the main focus of the community; instead, learning can be an incidental outcome (Wenger-Trayner, Wenger-Trayner, 2015; Wenger, Snyder, 2000), in the sense that participating in a CoP inevitably affords some sort of knowledge (Nistor, Fischer, 2012).

There are three crucial dimensions that shape a community of practice, namely, (i) a domain, (ii) a community, and (iii) a practice (Snyder, Wenger, 2010; Wenger-Trayner, Wenger-Trayner, 2015). The strength of these dimensions ensures the CoP's effectiveness as a social learning system (Snyder, Wenger, 2010). In Figure 1, the larger circle represents the domain of interest and the smaller circle represents the community. Little black dots represent individuals, whereas interaction, represented by the links among them (within the community), establish practices.

Membership in a CoP implies a commitment to a shared domain of interest that, in turn, reflects the identity of the community itself, but may not be recognized as a knowledge area outside of the community (Snyder, Wenger, 2010; Wenger-Trayner, Wenger-Trayner, 2015).

The sense of community is essential. In pursuing their interest in their domain, members engage in joint activities and build relationships that enable learning from each other, even if they do not necessarily work together (Snyder, Wenger, 2010; Wenger-Trayner, Wenger-Trayner, 2015).

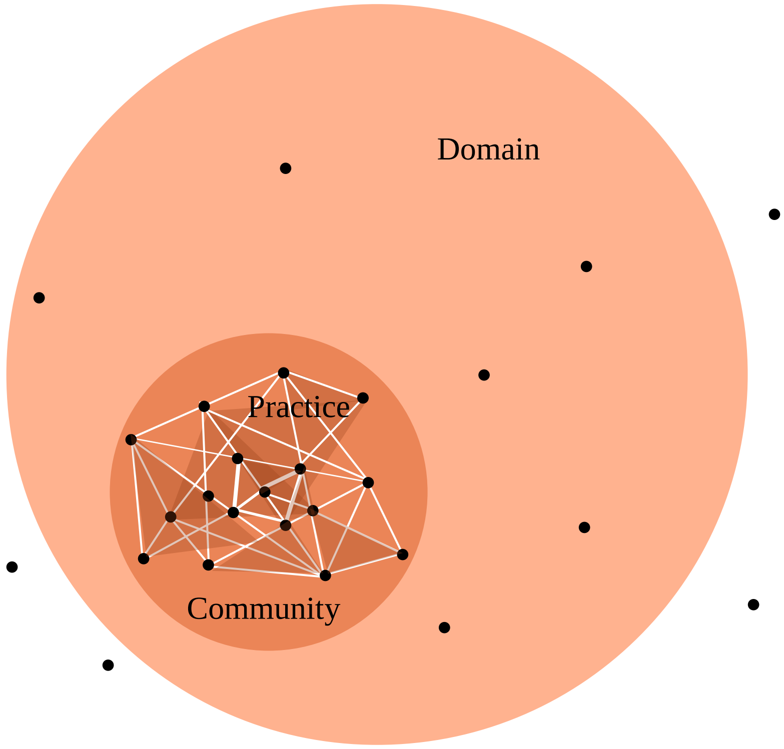

Fig. 1. Dimensions of a community of practice

The practice is developed through time and sustained interaction. As the members interact, they develop, in a more or less self-conscious way, a shared repertoire of resources for addressing problems (Snyder, Wenger, 2010; Wenger-Trayner, Wenger-Trayner, 2015).

CoPs can be found in different areas, such as business, government, or health. When they develop among educational actors, specifically, they can be a suitable tool for professional development (Wenger, 2010).

Although their results cannot be generalized, Tseng and Kuo (2014) demonstrated that through online professional CoPs, teachers were involved in the creation, application, and distribution of knowledge. Their membership in an online professional CoP contributed to their willingness to share resources and help other members to solve problems (Tseng, Kuo, 2014). In line with these results, a Portuguese case study of a CoP of teachers and researchers, with previous experience working together, contributed to the acknowledgement of teachers' CoPs as a potentially effective way to achieve professional pedagogical development (Marques et al., 2016).

Although communities of practice have been around for a long time (Snyder, Wenger, 2010; Wenger, Snyder, 2000), they are not particularly easy to build, due to their organic, spontaneous, and informal nature, which makes them resistant to supervision and interference (Wenger, Snyder, 2000). A healthy CoP is dynamic (Polin, 2010) and, in contrast to natural communities, intentional communities need to rely on invitations to interact, since many of them collapse because they lack the energy to sustain themselves (Wenger et al., 2002). Thus, a good community design needs to identify the direction of the community, emphasize its character, and provide the energy necessary to its growth (Wenger et al., 2002), as informal learning activities and personal relationships are at the basis of communities of practice (Snyder, Wenger, 2010).

The activities of a CoP can differ across modalities and rhythms. In addition to creating knowledge, activities also increase the sense of belonging (Snyder, Wenger, 2010), leading to the establishment of distinct boundaries between those who belong and those who do not (Wenger, 2010).

Wenger et al. (2002) presented, based on their experience, seven principles that reflect their understanding of how different design elements should work:

"1. Design for evolution.

2. Open a dialogue between inside and outside perspectives.

3. Invite different levels of participation.

4. Develop both public and private community spaces.
5. Focus on value.
6. Combine familiarity and excitement.
7. Create a rhythm for the community". (p. 51)

Harvey, Cohendet, Simon, and Dubois (2013), on the other hand, have stated that CoPs cannot be deliberately planned and configured, further suggesting that they should rather be considered as a social phenomenon and not as a learning tool. We should further note that the relationships among the fundamental notions of CoPs have been mainly described based on results from qualitative studies and are not yet sufficiently validated based on quantitative evidence (Nistor, Fischer, 2012). In fact, there are very few records of CoPs projected by organizations, and, of the existing records, none provide enough data to analyse the process (Harvey et al., 2013).

Adding to this, the fact that a community of practice relies so deeply on a concept of membership that has different meanings in different contexts (Gee, 2004, 2005) makes it necessary to stimulate a sense of belonging among the various individuals within a collective environment to feed the development of the community, since it should remain alive by the activities of its members and not by external imposition (Harvey et al., 2013).

In their research involving 57 organizational CoPs, Probst and Borzillo (2008) identified three of the five main reasons of failure: the lack of a core group, the low level of interaction between members, and the lack of identification with the CoP. These results led us toward another social configuration where participation, interaction, and learning take place—affinity spaces (Gee, 2004, 2005).

4. Affinity spaces

Approaching affinity spaces differs from examining communities of practice in the sense that, at least initially, we should address the space and not the groups of people; we first explore the limits of these spaces and the interactions that occur there, and later, if necessary, define the community that develops there (Gee, 2004, 2005).

These affinity spaces are, according to Arnone, Small, Chauncey, and McKenna (2011, p. 184), "experimental, innovative, having provisional rather than institutional structures, adaptable to short-term and temporary interests, ad hoc and localized, easy to enter and exit on demand and very generative". Studies conducted on three online affinity spaces verified transformative works associated with the specific fan culture of each of these spaces by taking an artefact and giving it a new function or expression through a variety of methods and means (Curwood et al., 2013).

The use of the term 'affinity space' rather than 'affinity group' is thus intentional. Groups are often defined by the space in which people associate rather than on an immediate criterion of affiliation (Gee, Hayes, 2012). From this perspective, the aim of people's affinity in these spaces is not the other people, but the endeavour or interest around which the space is organized (Gee, 2004). The organization of the space is as important as the organization of people, and the interaction between people and space has its own relevance (Gee, Hayes, 2012).

Affinity spaces may have a physical or a virtual location (Gee, 2004). Nonetheless, Gee and Hayes (2012) have stated that the Internet is a conducive medium for the generation of these spaces. Affinity spaces are included in what Gee (2004) called 'semiotic social spaces' (SSS), due to his concern about signs and meanings in these locations (Gee, 2005). They are defined by (i) content, (ii) generators, and (iii) portals. The content (i) refers to something about which this space is developed; the generators (ii) represent everything that can generate content; and the portals (iii) allow access to the space (not the group), being everything that makes possible the contact with the content, as the ways of interacting with this content, individually or with other people (Gee, 2004).

Gee (2004) also lists a set of eleven features that exist in an affinity space, which may eventually be used as a checklist to verify approximation of an SSS to an affinity space. Hayes and Gee (2010), on their view on public pedagogy through video games, later reduced the list to ten items:

'1. People relate primarily in terms of common interests and not in terms of race, gender, or age;

2. There is a *continuum* of new to experienced, and everything in between, in the same space, as there is no segregation from unskilled to highly skilled.

3. Everyone can generate material that changes the space;
4. Intensive and extensive knowledge is enabled and encouraged;
5. Individual and distributed knowledge is enabled and encouraged;
6. Dispersed knowledge is encouraged and enabled;
7. Tacit knowledge is encouraged, enabled, and honoured;
8. There are different forms, degrees, and routes to participation;
9. Different routes to status exist in the space;
10. Leadership is porous and leaders are resources'. (p. 188)

As seen in these principles, there are different degrees of participation, allowing everyone to be in the affinity space. According to Gee and Hayes (2012), it seems that the majority of people in the affinity space produces the minority of content, and a minority of people produces the majority of the content. This means that a person can be a high contributor in one affinity space and a low contributor on another, if they wish, according to their passions.

There may be different types of affinity spaces, some of which may be inclusive or supportive, giving people a sense of belonging and cooperation, but they can also stimulate competition for status (Gee, Hayes, 2012).

Gee and Hayes (2012), during their study of different sites associated with *The Sims* game, reported that different sites work in different ways, but some are organized in a way that favours learning, with these spaces being firstly referred to as nurturing affinity spaces. Currently, they are referenced as passionate affinity spaces (PAS) (Gee, 2015).

The list below shows the set of features seen in PAS (Gee, 2015), although it should be noted that the creation of a space that has all the features is indeed difficult and its maintenance involves work (Gee, 2013; Gee, Hayes, 2012):

'1. The space is defined by members' passion for a common endeavour, not their race, gender, age, disability, or social class;

2. Participants share a common space regardless of age, experience, expertise, or goals;

3. Participants can produce—not just consume—content; new content is judged by the standards of the space;

4. Social interaction transforms content;

5. The space encourages the development of broad, specialist, individual, and distributed knowledge—creating a new view of expertise as collective;

6. The space facilitates dispersed knowledge through access to off-site sources;

7. The space honours tacit knowledge (such as knowledge attained through trial and error) and encourages explicit knowledge (such as the codified knowledge found in tutorials and forums);

8. The space offers different ways to participate, and different routes to status;

9. Leaders are resources; roles shift frequently, as leaders become learners, learners become leaders, producers become consumers, and consumers become producers;

10. The space supports and encourages producers by providing peer feedback and/or a consumer audience;

11. The space promotes an idea of learning as a proactive, self-propelled process that may require group resources and may involve failure'. (Gee, 2015: 196–197)

According to Krutka, Bergman, Flores, Mason, and Jack (2014), 77 pre-service teachers considered that they evolved as teaching candidates through interactions with peers, in a digital space that presented some of the main characteristics of an affinity space.

We, as Jones, Stephens, Branch-Mueller, and de Groot (2016), instead of seeing affinity spaces and CoPs as separate concepts, see them strongly overlapped, recognizing the space as a strong determiner of community. In fact, Lammers, Curwood, and Magnifico (2012) have stated that social media is now an intrinsic part of participating in these spaces, which are in constant flux, as portals to affinity spaces arise, change, and disappear.

In this way, Lammers et al. (2012), starting on the affinity space concept, presented nine features of an expanded notion, where socializing plays an important role, as not all participation is solely focused on the common endeavour, but contributes to build the community within the space:

'1. A common endeavour is primary;
2. Participation is self-directed, multifaceted, and dynamic;
3. Portals are often multimodal;
4. Affinity spaces provide a passionate, public audience for content;

5. Socializing plays an important role in affinity space participation;
6. Leadership roles vary within and among portals;
7. Knowledge is distributed across the entire affinity space;
8. Many portals place a high value on cataloguing content and documenting practices;
9. Affinity spaces encompass a variety of media specific and social networking portals'. (pp. 48–50)

Are these spaces of learning, where knowledge is not restricted to a core of experts, where true innovation is more likely to occur due to high heterogeneity of skills and backgrounds (Gee, Hayes, 2012), providing the conditions of genesis and sustainable development of an online community? Are these spaces capable of challenging teachers to adopt and generate scientific peer review and validation processes? Will these spaces be able to reduce the gap between researchers and teachers?

5. mSciences: A brief description

Among other objectives, the first phase of a project entitled 'Multimedia in science teaching: five years of research and teaching in Portugal' aimed to understand what academic studies publicly released and made available in Portugal between 2010 and 2014 had to tell us about the usage of multimedia in science teaching (for complete results, see Paiva et al., 2015; 2016).

The systematic review of literature was based on a corpus consisting of 75 works (Table 1). These academic studies were organized in an open online repository that allowed visitors to upload and revise other academic works.

Table 2. 'Multimedia in science teaching: five years of research and teaching in Portugal' corpus of study.

Field	Percentage of works
Mathematics	49 %
Physics	15 %
Natural Sciences	14 %
Chemistry	11 %
Biology	7 %
Geology	4 %

Through an action-research process, the current platform (Mota et al., 2017) is the object of pertinent modifications to implement features based on the Lammers et al. (2012) expanded notion (Table 2) of creating a dynamic community that surpasses the difficulties of transmitting and sharing knowledge among science teachers and researchers.

Table 2. Modifications to implement features based on the Lammers et al. (2012) expanded notion on the affinity space concept.

Feature	Notion	Action
1. A common endeavour is primary.	The common endeavour aggregates participants in affinity spaces and not other social factors.	▪ Project Name and Identity. ▪ Project public presentations.
2. Participation is self-directed, multifaceted, and dynamic.	There are different modes and ways of participation, as well as different paths to status within affinity spaces.	▪ Social Networks connection ▪ Comment section ▪ Forums
3. Portals are often multimodal.	Despite the importance of discussion panels as key portals when the	▪ Social Networks connection

Feature	Notion	Action
	concept was developed, many online portals encourage now multimodal participation, using different media.	▪ Comment section ▪ Forums ▪ Enable Work uploading ▪ Open Repository Restructuration
4. Affinity spaces provide a passionate, public audience for content.	Social status can be gained by sharing knowledge within the space, making the affinity space participants an audience for content that they can respond to, as active members or even collaborators.	▪ Social Networks connection ▪ Comment section ▪ Forums ▪ Rating ▪ Status display (Subscriber, Collaborator, Author)
5. Socializing plays an important role in affinity space participation.	The endeavour is not the only focus of all participation, as other practices, designed to build community within the space, play an important role.	▪ Internal social network
6. Leadership roles vary within and among portals.	Portals have leaders that can fill different roles within a portal as they can be moderators, administrators, designers, and facilitators, or any other role existing in the affinity space.	▪ Available leadership roles (Author, Administrator)
7. Knowledge is distributed across the entire affinity space.	Knowledge and content are distributed, broadening the affinity space.	▪ Comment section ▪ Forums ▪ Open Repository Restructuration ▪ How to Section
8. Many portals place a high value on cataloguing content and documenting practices.	Knowledge is explicitly distributed and organized.	▪ Forums ▪ Open Repository Restructuration
9. Affinity spaces encompass a variety of media specific and social networking portals.	Often affinity spaces are connected to existing social networks that contribute to the growth and to a dynamic participation of the spaces.	▪ Social Networks connection

In this way, an effort is being made to create a project name and identity (Fig. 2), as well as the presentation of the project to the target audience, because '*the common endeavour, and not other social factors, brings participants together in affinity spaces*' (Lammers et al., 2012: 48).

Fig. 2. Home page interface

The repository search was limited, being dependent on a reduced number of filters and on not allowing associations between similar contents, nor on the sharing of knowledge and the feedback of the participants regarding the quality and application of the available works in a learning environment.

To enable the exchange of knowledge, the open repository was restructured into several categories (namely, scientific content area, multimedia, and pedagogical perspective) (Fig. 3) and new functionalities were applied, such as evaluation and comments, allowing information feedback to researchers regarding the application of their work (Fig. 4).

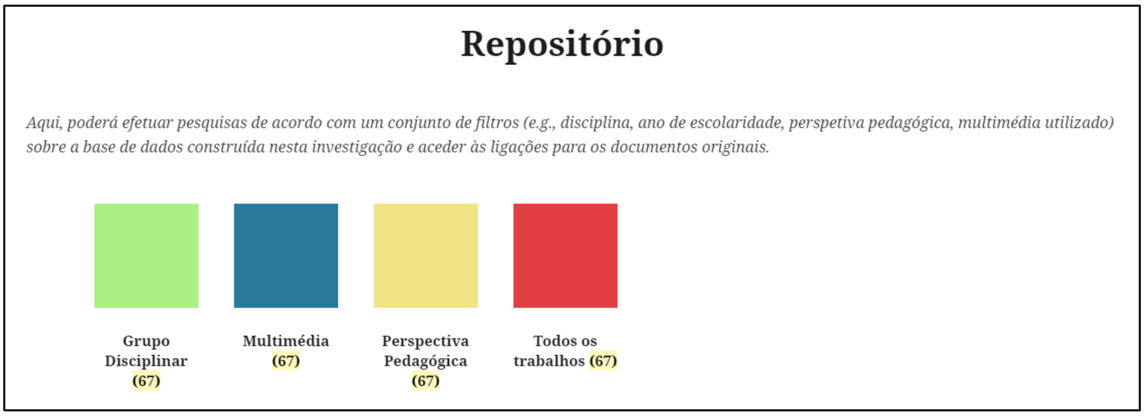

Fig. 3. Repository interface and restructuration into several categories

Fig. 4. New functionalities applied, such as evaluation and comments, to the repository interface

The connection to social networks has also been established, through the integration of existing platforms and sharing buttons (Fig. 5). An internal social network was also integrated, allowing registration, establishment of public profiles, internal roles, comments, friendships, and participation in the forums.

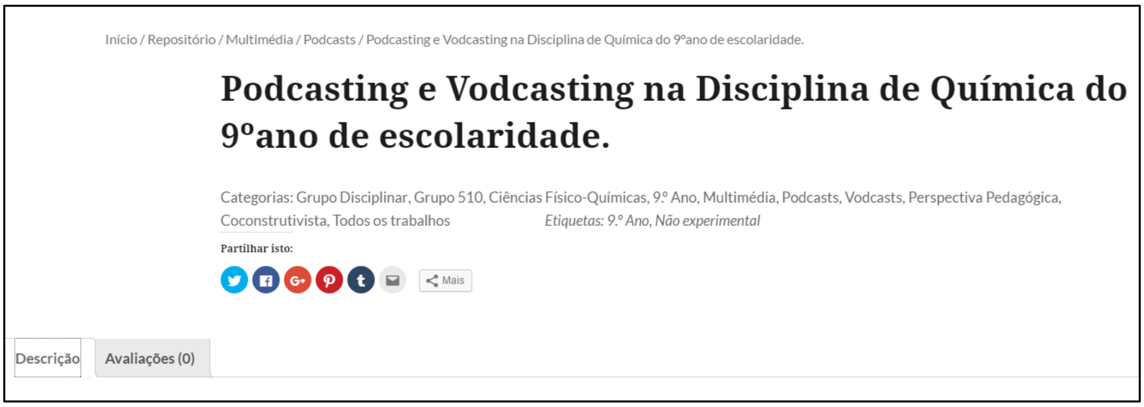

Fig. 5. Connection to existing social networks.

Articles showing 'how to' or disseminating other projects or multimedia were also produced and disseminated through the platform, social networks, and e-mail. Researchers have also been invited to present their work on our platform. Existing social network portals related to science teaching were also used to disseminate the project. These changes were made to not only to attract but also to maintain an interested public to progressively create a peer community that would smooth the gap between academic practice and teaching practice.

6. Conclusions

In this paper, we examined the concepts of community of practices (CoPs) and affinity spaces to guide and support the transformation of an open access repository into a participated space could reduce the gap between researchers and educators by allowing knowledge sharing and the dissemination of best practices.

Science education is fundamental to society, for economic, utilitarian, cultural, democratic, and moral reasons. Literate citizens are more likely to understand the world around them, and to thus make informed decisions about the social challenges and their own well-being. However, there is a gap between scholars and educators prevents science teachers from having easy access to best practices, new pedagogical proposals based on multimedia, and information about critically adopted pedagogical and communicational strategies in their formal and informal practices. Recent changes in the labour market that have made education more unstable, as have changing social expectations on teachers' roles; these may affect teachers' identity status and inhibit them to move beyond curriculum or classroom contexts. Because of these hurdles, we are wasting opportunities and resources to promote citizens' scientific literacy, qualify teachers, and challenge researchers.

Affinity spaces may contribute to feed a knowledge-driven society, taking the best out of its human resources and devising opportunities to educate citizens towards a greater understanding of science.

Keeping in mind that there are scarce empirical accounts for the process of development of an affinity space and of the significance that such spaces assume for their users—not to mention its impact in their practices—the detailed accounts made in this paper may enlighten future research, establishing the conditions for comparative results on the medium term.

Knowledge sharing, work dissemination, and update of information to improve real, day-to-day teaching activities are some of the advantages afforded by the mSciences affinity space through interaction with the platform. The space was also built to allow different levels of participation and interaction, as well as to enable the production and consumption of content, although, as seen in other affinity spaces, most participants are consumers and the minority are producers.

It also relevant to state that this is not meant to be an exclusively qualitative study. In fact, at this moment, we are handling data from primary and science teachers gathered through a questionnaire developed upon the theory of planned behaviour (Ajzen, 1991, 2006). Also, platform statistics as to number of views, visitors, registered users, comments, publications, and social networks integration, gathered through such metrics as the number of page likes, followers, reactions, and shares, are being monitored.

We hope that this combined approach will contribute to an empirically based analysis of the principles behind affinity spaces that can be useful to enable systematic comparisons across different locations and domains of interest.

Future work will be needed on the evaluation of the capability of appropriating knowledge, generating scientific peer review, and validation processes by mSciences participants.

7. Acknowledgement

Luciano Moreira is supported by the FCT grant: PD/BD/114152/2015.

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