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MULTIMEDIA IN SCIENCE TEACHING: FROM A REPOSITORY TO AN EDUCATION COMMUNITY

Jorge Miguel Gonçalves da Mota

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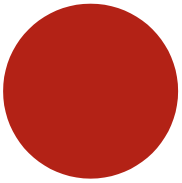

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Mestrado em Multimédia da Universidade do Porto

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Resumo

No passado, além do desenvolvimento científico, a tecnologia já esteve associada à transformação das práticas educacionais e, hoje, as orientações europeias apontam para uma nova transformação na educação através das tecnologias da informação. Partindo de uma perspetiva nacional sobre o uso dessas novas tecnologias, o projeto Multimédia no ensino das ciências: cinco anos de pesquisa e ensino em Portugal evidenciou uma lacuna entre investigação e ensino. Existe, assim, uma necessidade de colmatar essa lacuna, através do estabelecimento de uma comunidade de professores e investigadores, a fim de facilitar inovação real na educação científica em Portugal.

A revisão da literatura permitiu encontrar duas diferentes conceções emergentes, as comunidades de prática e os espaços de afinidade, cuja fusão guiou o desenvolvimento de uma plataforma (http://spq-ffms.spq.pt/) através de um processo de investigação-ação, permitindo assim a criação de bases para alojar uma comunidade online de professores e investigadores.

A intenção para a participação nesta plataforma de 60 professores de ciências também foi objeto de estudo à luz da Teoria do Comportamento Planeado, demonstrando uma grande relevância do controle comportamental percebido sobre a intenção positiva de participação detetada.

A participação e a interação também foram analisadas através de um questionário aberto online, envolvendo nove participantes, colocados em quatro grupos de acordo com diferentes tipos de interação e participação. Os resultados confirmam a

importância de uma comunidade de intercâmbio de conhecimento e permitem esclarecer e complementar os resultados obtidos nos estudos anteriores.

Considerando a distância entre a produção académica e a prática pedagógica, o projeto assume a sua importância definindo as condições de génese de uma comunidade de afinidade de professores e examinando as crenças e intenções dos professores para a participação nessa comunidade.

A comunidade de afinidade desenvolveu-se num espaço dinâmico, em torno de um interesse comum, onde os aspetos sociais são fundamentais para o seu crescimento, podendo, no futuro, promover a partilha e a apropriação de práticas de integração multimédia no ensino, validação e revisão de pares, reduzindo progressivamente a distância entre investigadores e professores.

Palavras-chave: Multimédia; ensino; ciências; comunidades de prática; espaços de afinidade.

Abstract

In the past, in addition to scientific development, technology has already been linked to the transformation of educational practices and, today, European guidelines point to a new transformation in education through information technologies. Starting from a national perspective on the use of these new technologies, the project *Multimedia in science teaching: five years of research and teaching in Portugal* evidenced a gap between research and teaching. There is thus a need to bridge this gap, by the establishment of a community of teachers and researchers in order to facilitate real innovation in science education in Portugal.

The literature review allowed to find two different emerging conceptions, the communities of practice and the affinity spaces, whose fusion guided the development of a platform (http://spq-ffms.spq.pt/) through an action-research process, thus enabling the creation of the basis for hosting an online community of teachers and researchers.

The intention towards the participation in this platform of 60 science teachers was also object of study under the Theory of Planned Behavior, demonstrating a high significance of perceived behavioral control on the detected positive intention of participation.

Participation and interaction were also analyzed using an online open-ended questionnaire, involving nine participants, placed in four groups according to different types of interaction and participation. The results confirm the importance of a knowledge exchange community and allow to clarify and complement the results obtained in previous studies.

Considering the gap between academic production and pedagogical practice, the project assumes its significance by defining the conditions of genesis of an affinity community of teachers, and by scrutinizing the beliefs and intentions of teachers towards participation on such community.

The affinity community developed in a dynamic space, around a common interest, where the social aspects are fundamental for its growth, may in the future foster the sharing and ownership of multimedia integration practices in teaching, peer validation and review, thereby further reducing the distance between researchers and teachers.

Keywords: Multimedia; teaching; sciences; communities of practice; affinity spaces.

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Abbreviations and Symbols

CoP	Communities of Practice
FCUP	Faculdade de Ciências da Universidade do Porto
ICT	Information and Communications Technology
ICT-ELI	Information and Communications Technology – Enabled Learning Innovations
PAS	Passionate Affinity Spaces
SSS	Semiotic Social Spaces
STEM	Science, Technology, Engineering and Mathematics
TPB	Theory of Planned Behavior

Introduction

Context

The present dissertation proposal originates from the project *Multimedia in science teaching: five years of research and teaching in Portugal* (Paiva, Morais, & Moreira, 2015), which presented the national research on multimedia in science education and provided the community with a repository of open access scientific texts – that would allow the weighting on teaching practices in science, technology, engineering and mathematics (STEM) areas using information and communication technologies (ICT) and refining them from a participatory science viewpoint.

This work intends to continue this last section, analyzing the conditions of genesis and sustainable development of an online community on science teaching, capable of appropriating and generating scientific peer review and validation processes.

Dissertation Project

Based on the literature on social learning systems, such as communities of practice and affinity spaces, a syncretic notion was adopted to lead an action-research process. The online platform (http://spq-ffms.spq.pt/) was therefore object of pertinent modifications in the sense of implementing strategies able to attract and to fix an interested public and progressively to create a community of peers.

The project is particularly relevant in the national context, bearing in mind the academic production and pedagogical practice gap, but also internationally, and it is possible to anticipate comparative research lines with other realities.

Research Objectives

The work developed is guided by four main research objectives:

1. Identify and reflect on the conditions of genesis and sustainable development of an online and participatory community on science education using multimedia.

2. Identify, implement and evaluate strategies capable of attracting elements, thus contributing to the progressive development of an active community of peers.

3. Reduce the distance between academic production and pedagogical practice by allowing open access to the latest knowledge on multimedia use in science teaching.

4. Analyze the beliefs, intentions and the behavior of teachers towards participation on an online community of teachers and researchers on multimedia in science teaching.

The first two are linked to the development and long-term maintenance of a community, the third is in turn associated with the reduction of the gap between teachers and researchers, and the latter linked to the behavior of teachers' participation in the developed community.

Research Methodology

The current dissertation presents three distinct empirical studies to achieve the proposed objectives, presenting each one of these studies its own methods for doing so.

In the first of these studies, due to its nature, we apply an action research methodology to improve the simple existing platform, enabling its gradual and progressive transformation into a space of exploration, dissemination and sharing for researchers and science teachers.

In the second study we resort to Ajzen (1991) Theory of Planned Behavior (TPB) to research the intention of participation (registration, sharing or comment on projects, practices or resources) in the space of affinity mCiências, by science teachers.

In the third and last study, we apply a thematic analysis to the qualitative data originated by an online questionnaire provided to participants that interacted in different degrees with mCiências platform.

Structure of the Dissertation

This study, which begins in this introductory section, with a brief contextualization, problematization and relevance, is organized into four chapters in order to facilitate its analysis and understanding.

In the first chapter, the theoretical framework of the research is carried out by means of a literature review. In the first part, we examine the need to overcome the gap between teachers and researchers in the use of multimedia in science education, and, in the second part, social learning systems such as communities of practice and affinity spaces are analyzed.

The second chapter aims to present the general design of the research, that is, to indicate the methodological options used in each of the three studies, characterizing the participants, the data collection instruments used, as well as the procedures used in the treatment and, finally, we present the results obtained in each of the studies.

In the third chapter, there is a joint discussion of the results obtained considering the research guiding questions, thus analyzing the consequences of our conscious introduction of changes and identifying our general findings.

The fourth and last chapter presents the subsequent conclusions, the study reflections, limitations and open questions for future research.

At the end of this dissertation are the bibliographical references fundamental for the development of these works as well as the appendices considered relevant for the understanding of this research work.

1. Literature Review

Learning, teaching and communicating science implies very often the use of technology and, in Portugal, multimedia has its own place in the science teaching legal documentation, being mainly used to promote learning and the development of transversal competences associated with scientific and digital literacy (Paiva et al., 2015).

During the last decades, researchers have tried to understand how people learn using information and communications technology (ICT), and there are several approaches to teaching that have emerged from different theoretical perspectives such as behaviorism, constructivism and cognitivism (Pange, Lekka, & Toki, 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, being these new teachers not only willing to try different kinds of ICT but also seeking opportunities to do so, with their students' interests as a priority, as shown by Martinovic and Zhang (2012).

However, this is not always the case or free from difficulties because some problem areas have also been detected, such as: the lack of modeling 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 is also difficult to provide, as there is a separation of content knowledge learning from educational methods in teacher training programs (Han, Eom, & Shin, 2013).

Policy actions, suggested from the ET2020 Working Group on Schools Policy, in order to improve Initial Teacher Education, state the need to improve practice through links with research (Commission, 2015) and, in Europe, although the infrastructure and a solid research base exists, 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, Kampylis, & Punie, 2014).

The Europe 2020 strategy also recognized the need for a change in education in order to achieve new skills and competences, thus establishing innovation as a key priority in several of its initiatives. This report, involving around 300 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).

This real gap between research and practice, 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, for Reich, Gemino, and Sauer (2012), in an organization, high quality results are not necessarily obtained with the most competent workers but rather with elements that, besides being competent, are motivated for effective practices of knowledge and knowledge sharing, which will allow for knowledge to become explicit in a perceptible form that can be internalized and applied by other individuals, using, extending and reframing it, in their own tacit knowledge (Nonaka, 1991).

In order to facilitate this sharing of knowledge as well as of good practice, many have turned to information technology, but found that, despite its advantages, this was not enough for this sharing to succeed (Brazelton & Gorry, 2003). Ipe (2003) identified 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. Tseng and Kuo (2014) state that performance expectation and self-efficacy belief are relevant in knowledge-sharing between teachers.

Open access to the 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 sharing of knowledge (Communities, 2007). All this work, freely available, would also profit with the pronouncement of teachers, researchers and experts on STEM teaching practices (Paiva et al., 2015), 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 analyzing Portuguese research on multimedia in science education and, on the other side, in making available a simple query tool associated with a repository of open-access scientific texts (Paiva et al., 2015). This would allow access to the beneficial integrative knowledge about technology uses that is pedagogically appropriate and can work in subject specific contexts (Han et al., 2013), but the results of its use are discouraging.

Kuo and Young (2008) results evidenced that in fact people do not always behave consistently in knowledge sharing, and explaining human behavior in all its complexity presents itself as a complicated task (Ajzen, 1991).

According to the TPB, we must address three types of considerations that guide human action: behavioral beliefs, normative beliefs and control beliefs, which together determine behavioral intention (Ajzen, 2006a, 2006b). Intentions represent antecedents of behavior (Ajzen, 2006a, 2006b) and therefore are indicative of the amount of effort that people are willing to apply to manifest particular behavior, because the stronger the

intention to manifest a particular behavior, the more likely it is to perform it (Ajzen, 1991).

So how can we drive these researchers and teachers to knowledge sharing in order to close this gap?

Brazelton and Gorry (2003) state that there needs to be a common purpose to make people use the collaborative tools for knowledge sharing, and Smith (2001), although referring to organizations, points 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, in order to enhance learning and the dissemination of tacit and explicit knowledge (Smith, 2001).

1.1 Communities of Practice

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 (CoP).

Naturally existing communities of practice 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, because learning can occur, but it may not be the main focus of the community, as it can be an incidental outcome (Wenger-Trayner & Wenger-Trayner, 2015; Wenger & Snyder, 2000), since participation in a CoP can express knowledge (Nistor & Fischer, 2012).

There are three crucial dimensions (Figure 1.1) in order to classify a community as a community of practice – a domain, a community and a practice (Snyder & Wenger, 2010; Wenger-Trayner & Wenger-Trayner, 2015), the strength of which ensure its effectiveness as a social learning system (Snyder & Wenger, 2010).

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

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

The practice is developed through time and sustained interaction, as the members 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).

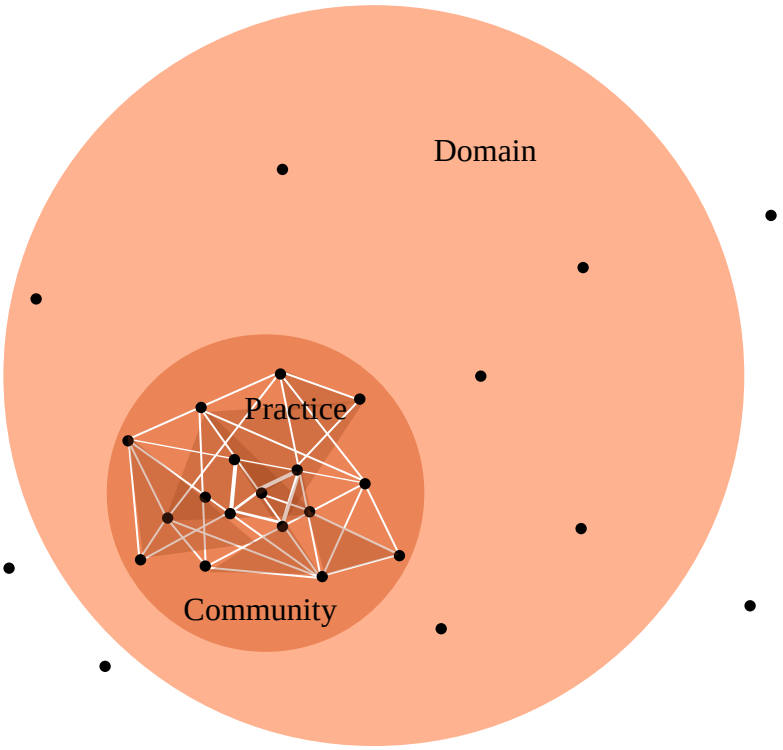


Figure 1.1. Dimensions of a CoP.

These communities can be applied in different areas, like business, government or health, and, in education, these communities can be used for professional development (Wenger, 2010).

Tseng and Kuo (2014) theoretically demonstrated that through an online professional CoP, 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). 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 teachers' professional development (Marques, Loureiro, & Marques, 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 that makes them resistant to supervision and interference (Wenger & Snyder, 2000).

A healthy CoP is dynamic (Polin, 2010) and, contrary to natural communities, intentional communities need to rely on the invitation to interact, since many of them collapse after they start because of lack of energy to sustain themselves (Wenger, McDermott, & Snyder, 2002b). It is thus necessary a good community design that identifies the direction of the community, emphasizes its character and provides the energy necessary to its growth (Wenger et al., 2002b), since informal learning activities and personal relationships are at the basis of communities of practice (Snyder & Wenger, 2010).

The activities of a community of practice can differ between modalities and rhythms and, in addition to creating knowledge, 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. (2002b, p. 51) 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."

Wenger, McDermott, and Snyder (2002a) also present some phases of a community development (Figure 1.2), where the early stages are of great importance on a CoP planning, by identifying the defining factors and by opening the community to new members.

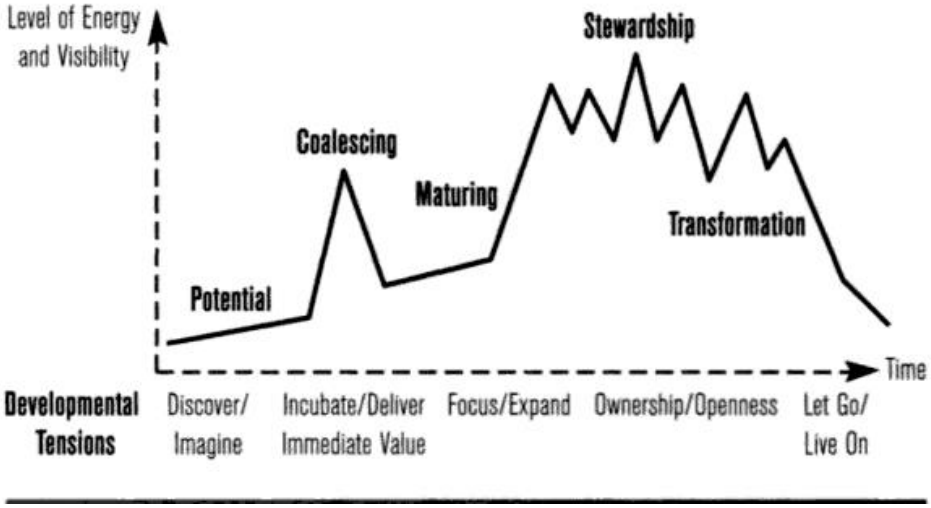


Figure 1.2. Community development stages (Wenger et al., 2002a, p. 69).

Harvey, Cohendet, Simon, and Dubois (2013), on the other hand, state that a CoP cannot be deliberately planned and configured, further suggesting that it should rather be considered as a social phenomenon and not as a learning tool.

Also, the relationships among the fundamental notions of CoPs have been mainly based on results from qualitative studies and are not yet sufficiently based on quantitative evidence (Nistor & Fischer, 2012). There are very few records of CoPs projected by organizations and, of the existing records, none provides enough data to analyze the process (Harvey et al., 2013).

Adding to this, the fact that a community of practice settles 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 foster the development of a CoP, since a CoP should be kept alive by the activities of its members and not by external imposition (Harvey et al., 2013).

Considering these aspects and, being the lack of a core group, the low level of interaction between members and the lack of identification with the CoP three of the five main reasons of failure identified by Probst and Borzillo (2008) in their research envolving 57 organizational CoPs, it led us on the way to another social configuration, where participation, interaction and learning also take place – the affinity spaces (Gee, 2004, 2005).

1.2 Affinity Spaces

Affinity spaces approach distances itself from the CoP, in the sense that, initially, we should address the space and not the groups of people, exploring first 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 in three online affinity spaces allowed to verify transformative works associated with the specific fan culture of each one of these spaces (Curwood, Magnifico, & Lammers, 2013).

The use of the term affinity space rather than affinity group is thus done intentionally, as groups are often defined by the space in which people associate rather than based on an immediate criterion of affiliation (Gee & Hayes, 2012). In this perspective, the aim of people's affinity in these spaces is not other people, but the endeavor or interest around which space is organized (Gee, 2004), an organization of

the space that is as important as the organization of people, and where the interaction between people and space has its own relevance (Gee & Hayes, 2012).

These spaces may have a physical or virtual location (Gee, 2004), although Gee and Hayes (2012) state 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 content, generators and portals, where the *content* refers to something about which this space is developed, the *generators* represent everything that can generate content, and the *portals* allow access to the space (and not to 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, in order to verify approximation of SSS to an affinity space, which were later reduced to ten by Hayes and Gee (2010, p. 188) on their view on public pedagogy through video games:

"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 honored;

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."

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

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

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 favors learning, 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, pp. 196-197), 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 endeavor, 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 honors 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 seen as resources. Roles shift frequently, as leaders become learners, learners become leaders, producers become consumers, 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.

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), presenting the conditions of genesis and sustainable development of an online community? Are these spaces capable of appropriating and generating scientific peer review and validation processes? Is there an intention of participation by science teachers in these spaces that in the future allow the gap reduction between researchers and teachers?

1.3 A syncretic notion

We, as Jones, Stephens, Branch-Mueller, and de Groot (2016), instead of seeing affinity spaces and CoP as separate concepts, see them strongly overlapped, recognizing the space as a strong determiner of community. In fact, Lammers, Curwood, and

Magnifico (2012) state 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, pp. 48-50), 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 endeavor, but contributes to build the community within the space:

"1. A common endeavor 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."

Through an action-research process, the current platform (http://spq-ffms.spq.pt/) developed on the *Multimedia in science teaching: five years of research and teaching in Portugal* (Paiva et al., 2015) project may be object of pertinent modifications in order to implement features to attract and to maintain an interested public, in a way to progressively create a community of peers that would soften the distance between academicals and teaching practice. The science teachers' behavioral intention of participation on a space like this will also be subject of study at the light of TPB.

2. Empirical Studies

In this chapter, we will address the three studies carried out, briefly referring some introductory points regarding the used methodology, to later focus on the description of the study itself, at the level of methods, participants, instruments, results and discussion.

2.1 Study 1 – Platform development

Study 1, due to its specificity, uses an action research methodology, in an attempt to create a dynamic community that surpasses the difficulties of transmitting and sharing knowledge among science teachers and researchers.

Action research was introduced by Kurt Lewin in 1946 in order to present a new approach to social research (Susman & Evered, 1978) and "is a method that could be described as a paragon of the post-positivist research methods. It is empirical, yet interpretive. It is experimental, yet multivariate. It is observational, yet interventionist." (Baskerville & Wood-Harper, 1996, p. 236).

Besides all its characteristics, action research consists on the diagnosis of a problem with an input on how to improve practice (Blum, 1955; McNiff, 2010) and presents two stages – diagnostic stage and therapeutic stage (Baskerville & Wood-Harper, 1996; Blum, 1955). In the first stage, we identify the problem and generate hypotheses, to be tested on the second stage, through an introduction of changes and study of their effects (Baskerville & Wood-Harper, 1996; Blum, 1955).

Action research links theory and practice, on a cyclical unfold of events (Figure 2.1), where successes and failures are equally meaningful, until the problem solution becomes clearer (Baskerville & Wood-Harper, 1996), enabling social and cultural transformation (McNiff, 2010).

Figure 2.1. The action research cycle. Adapted from Susman and Evered (1978).

In the previous section, we have identified the problem (diagnosing), considered alternative courses of action for solving the problem (action planning) through bibliographic review and selected a course of action (action taking), by conducting three different research studies to answer our research questions, and to help us overcome the gap between teachers and researchers.

2.1.1 Methods

In this section, some information will be provided to contextualize the actions carried out to bring the previous platform closer to a platform that will eventually house a community of exchange and sharing of knowledge and good practices regarding science teaching using multimedia. Data analysis, associated with the observed results, will also be addressed at this point.

2.1.1.1 Context and action taking

As a result of *Multimedia in science teaching: five years of research and teaching in Portugal* (Paiva et al., 2015), a platform was previously developed using

WordPress to provide some information about the project itself and the results of the project, mainly a free access repository containing the 75 research papers analyzed.

The online platform (http://spq-ffms.spq.pt/) was object of pertinent modifications, to progressively implement features based on the Lammers et al. (2012) expanded notion (Table 2.1). These modifications were made based on the existing platform, giving continuity to the use of the free and open-source content management system *WordPress*, and by selecting the appropriate available plug-ins for the intended purposes.

Table 2.1. Modifications in order to implement features based on the Lammers et al. (2012) expanded notion on the affinity space concept.

Feature	Action
1. A common endeavor is primary.	▪ Project name and identity. ▪ Project public presentations.
2. Participation is self-directed, multifaceted and dynamic.	▪ Social Networks connection. ▪ Comment section. ▪ Forums.
3. Portals are often multimodal.	▪ Social Networks connection. ▪ Comment section. ▪ Forums. ▪ Enable Work uploading. ▪ Open Repository Restructuration.
4. Affinity spaces provide a passionate, public audience for content.	▪ Social Networks connection. ▪ Comment section. ▪ Forums. ▪ Rating. ▪ Status display (Subscriber, Collaborator, Author).
5. Socializing plays an important role in affinity space participation.	▪ Internal social network.
6. Leadership roles vary within and among portals.	▪ Available leadership roles (Administrator, Author, Collaborator).
7. Knowledge is distributed across the entire affinity space.	▪ Comment section. ▪ Forums. ▪ Open Repository Restructuration. ▪ "How to" and project dissemination.

Feature	Action
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.*	▪ Forums. ▪ Open Repository Restructuration. ▪ Social Networks connection.

In this way, an effort was made to create a project's name and identity (Figure 2.2), as well as the presentation of the project to the target audience, because "the common endeavor, and not other social factors, brings participants together in affinity spaces" (Lammers et al., 2012, p. 48).

Figure 2.2. Home page interface.

The repository search was limited, being dependent on a reduced number of filters, not allowing associations between similar contents, nor, mainly, and considering the objectives proposed in this dissertation, 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) (Figure 2.3) and new functionalities were applied, such as evaluation and comments, allowing information feedback to researchers regarding the application of their work (Figure 2.4).

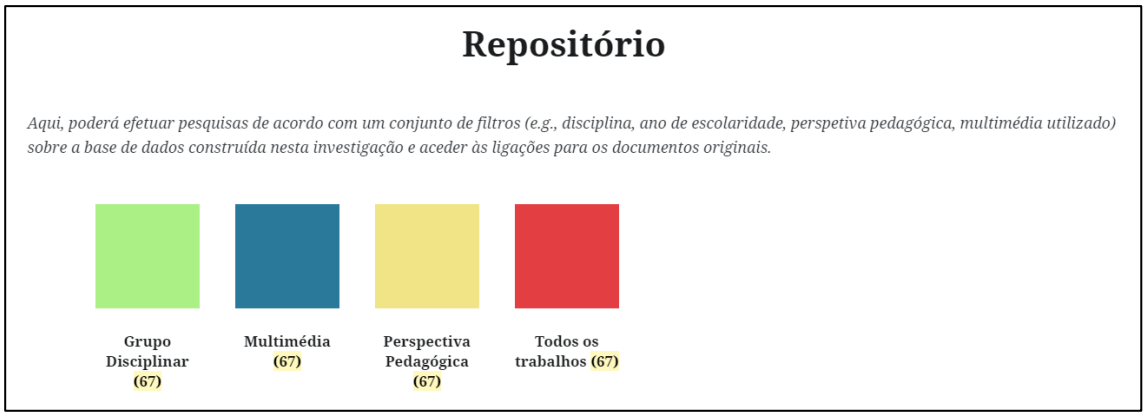


Figure 2.3. Repository interface and restructuration into several categories.

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

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 facebook portals related to science teaching were also used to disseminate the project.

Figure 2.4. New functionalities applied, such as evaluation and comments, to the repository interface.

2.1.1.2 Data analysis

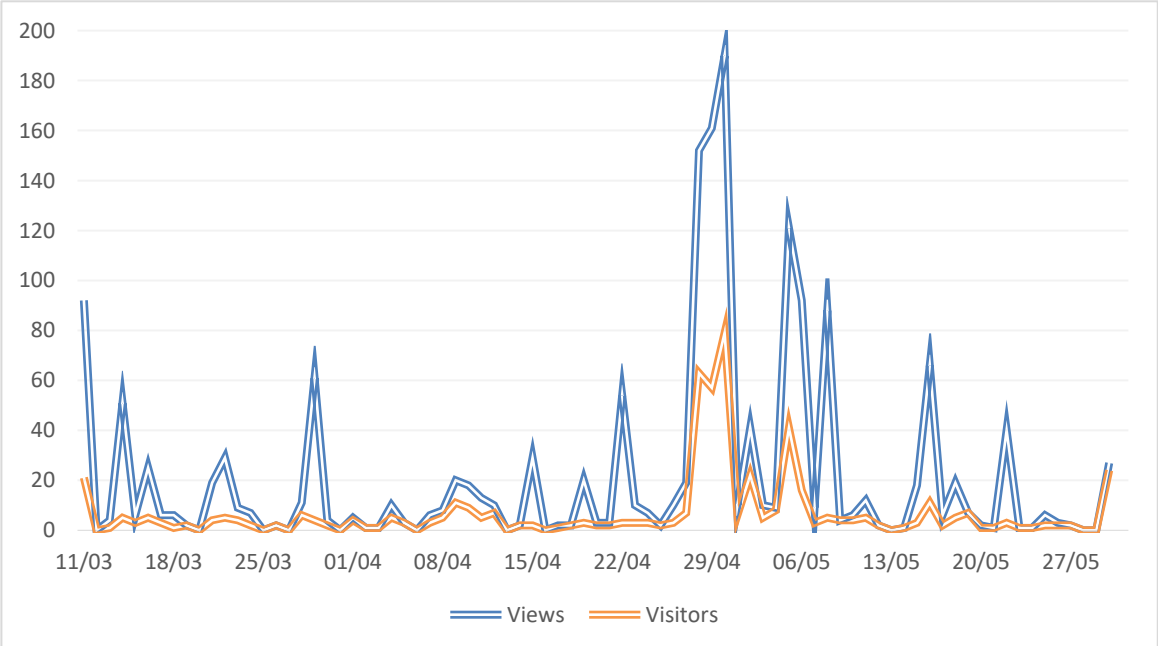
Platform statistics as to number of views and visitors were monitored between the first public presentation (March 11th) and May 30th. The number of registered users was also monitored, as to comments and publications, using WordPress integrated statistical analysis.

Regarding the social networks integration, the number of page likes, followers, reactions and shares was also monitored, in the same period that was referred above, using Facebook integrated statistical analysis.

2.1.2 Results

We begin our study with the assumption, according to our literature review, that the presentation of the project to an audience that shares a common endeavor, as well as the creation of a mCiências platform identity, would gradually attract more participants, helping the growth of the intended community.

In fact, before March 11th, the only visitors and views of the mCiências platform were the site administrators, but between March 11th and May 30th the total views of the mCiências were 1699, corresponding to a total of 545 visitors, from which we can calculate that the number of views per visitor corresponds to 3,177. The total distribution of views and visitors can be seen in Figure 2.5.



During this period, the number of users increased from the 5 administrators to a total of 17 registered users (7 subscribers, 5 administrators, 4 authors and 1 collaborator), and a total of 11 articles were published (Table 2.2) by the project team and authors. It should be noted that author A corresponds to the author of this dissertation, who during this work published articles on the mCiências platform, and authors B and C are invited researchers.

These user profiles are distinguished by the increasing autonomy level. Subscribers can participate in platform activities such as forums, collaborators can already publish articles with supervision of an administrator, which is no longer necessary for an author, and an administrator adds the functions of platform management.

Table 2.2. Articles published at mCiências platform.

Article	***Date***	***Author****
Software for creating and editing content	2017/05/24	A
Simulations and Virtual Labs	2017/05/04	A
QR Codes	2017/04/28	A
Digital educational resources for learning Chemistry through Music	2017/04/10	B
Animated infographics in science teaching	2017/04/08	C
Kahoot!	2017/03/28	A
Have you worked with Wikis?	2017/03/23	A
Augmented Reality	2017/03/21	A
Explore the Repository	2017/03/16	A
Multimedia in Science Teaching: Repository and Affinity Space for Teachers	2017/03/15	A
How to give life to your session card Multimedia in Science Teaching: Repository and Affinity Space for Teachers?	2017/03/08	A

** Publishing authors are identified by letters A, B and C.*

Although the comments and forums' sections present themselves as important areas of an affinity space, here, at mCiências, they were never used by visitors or registered users besides administrators, although one of the articles had 4 positive feedbacks using a specific contact form introduced by one of the authors (Table 2.3).

Table 2.3. Feedback on the "Digital educational resources for learning Chemistry through Music" article.

Feedback	***Date***
"I need this project ...";	30 April, 2017 at 11:22
"... this project seems very interesting to me. Thanks";	30 April, 2017 at 10:56
"I would like to share work done by students ...";	30 April, 2017 at 8:37
"Great way to motivate students".	30 April, 2017 at 8:16

An e-mail account has been created to disseminate published articles and to encourage the exploitation of the resources available in the free access repository (Table 2.4). A welcome e-mail message was sent to all the teachers who expressed their interest, on the available space at the questionnaire applied on study 2, and that left a valid e-mail address.

Table 2.4. Divulgation e-mails subject and sending date.

E-mail subject	***Date***
Already know our Facebook page?	18/05/2017
*Multimedia in the Teaching of Sciences **	10/05/2017
Simulations and Virtual Labs	05/05/2017
Already worked with QR Codes?	28/07/2017
*Multimedia in the Teaching of Sciences **	26/04/2017
Visit our Agenda	19/04/2017
Digital educational resources for learning Chemistry through Music	12/04/2017
Animated infographics in science teaching	10/04/2017
Have you worked with blogs?	07/04/2017
Kahoot!	28/03/2017
Wiki's in science teaching	23/03/2017
Augmented Reality	21/03/2017
Come and Explore the Repository	17/03/2017
*Multimedia in the Teaching of Sciences **	14/03/2017

** Welcome e-mail message*

Regarding the social networks integration, which poses an important role as access portal and socialization factor, the total number of Facebook page likes, followers, and the total number of publications/posts, as comments, reactions and shares, since March 11th to May 30th, are presented on Table 2.5, and individual publication data can be seen on Appendix A.

Table 2.5. Facebook page statistics.

Total Likes	**Total Followers**	**Total Publications/Posts**	**Maximum number of people reached through facebook**
101	103	19	
Total Reactions	**Total Comments**	**Total Shares**	
163	4	52	1941

The published 19 posts achieved 163 reactions and a total of 52 shares through social networks, reaching a total of 1941 individuals and granting our facebook page a total of 103 followers.

The frequent production of content could contribute to the increase of members of the community in mCiências by generating a community rhythm of functioning. Figure 2.6, on the next page, shows the number of views and visitors on mCiências between March 11th and May 30th, with the overlapping moments of article publication, e-mailing and social network sharing. The initial moment of sharing in teachers' facebook social groups of different disciplines is also represented.

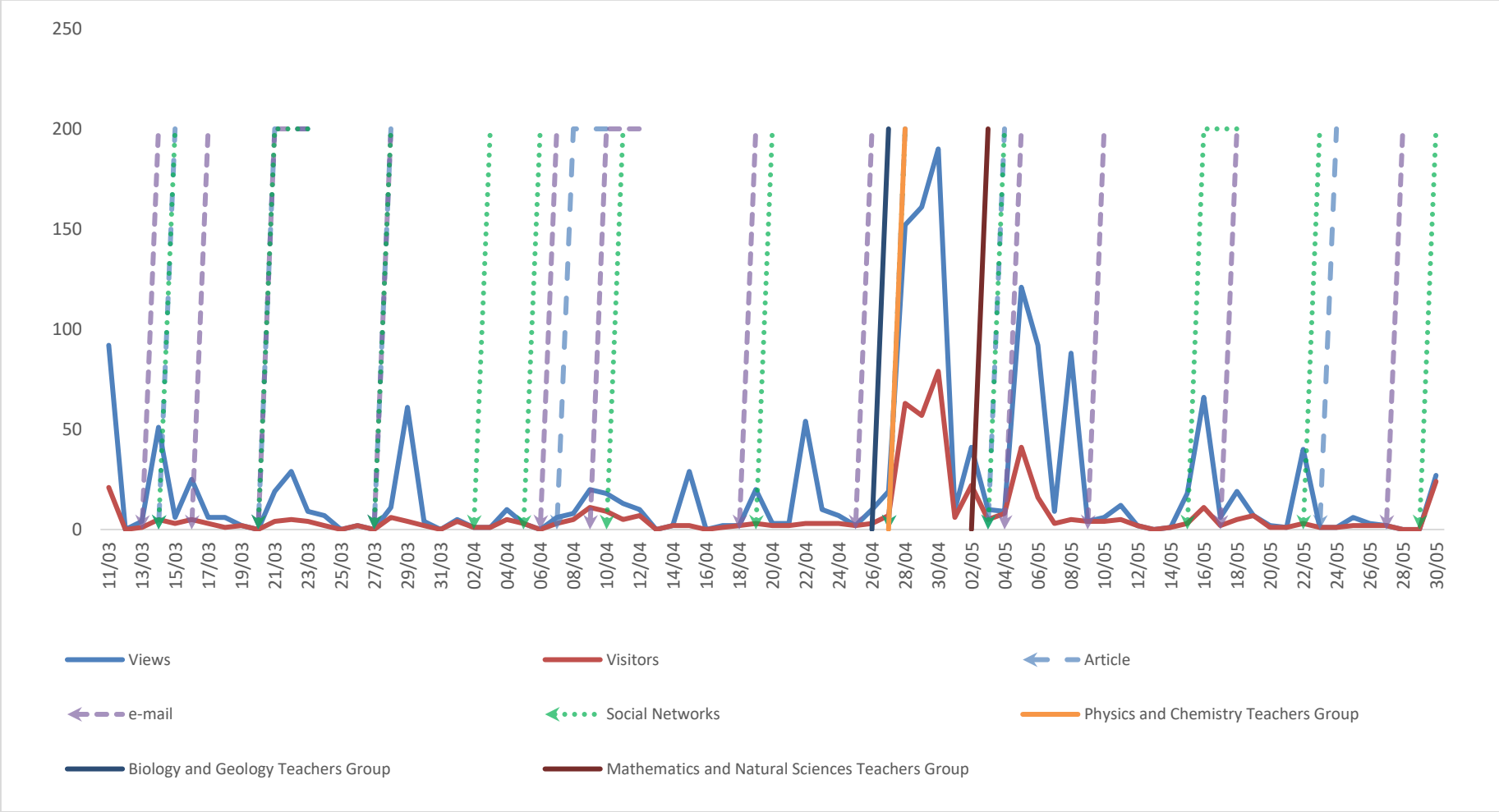


Figure 2.6. Number of views and visitors on mCiências, with article publication, e-mailing and social network sharing.

2.1.3 Discussion

The number of views and visitors, although reduced, considering the national panorama and the existing number of STEM teachers, is, despite everything, significant, as it only refers to a period of 81 days. After the public presentations of the project and its potentialities to groups of teachers, the number of visitors and page views increased, according to the notion that it is the common endeavor that aggregates participants in affinity spaces and not other social factors (Hayes & Gee, 2010; Lammers et al., 2012), as these teachers worked in different educational establishments, therefore not belonging to the same educational community.

Lammers et al. (2012) point socialization as an important factor in building the community within the space, but the internal community enabled features didn't succeed in doing this, although the existing social platforms granted our social page 605,88% more followers than the registered users.

In an affinity space, the identification and dissemination of good practices and/or knowledge are also of great importance, as knowledge is explicitly distributed and organized (Gee, 2015; Hayes & Gee, 2010; Lammers et al., 2012), broadening the affinity space, and not restricting it only to the free access repository. This contributed to the expansion of the mCiências affinity space and to the dissemination of projects and knowledge among participants.

Participants on mCiências could produce and not just consume content. As Gee (2015) advocated for affinity spaces, there stand different ways or levels of participation, and enabling these different levels of participation is also key factor on developing a community, according to Wenger et al. (2002b).

Regardless of the different roles or degrees of participation, just as Gee and Hayes (2012) noticed, a minority of people produce the majority of the content, as there were only three publishing authors. The production of content by authors B and C (invited researchers), thus feeding the community with external expertise, achieved the highest levels of dissemination, views and reactions from the audience, going in

accordance to what Probst and Borzillo (2008) defended as a success factor for an organizational CoP.

Despite the reduced amount of content producers, there was still the intention of creating a rhythm for the mCiências community, by continuously producing relevant content, since the rhythm of a community can be a strong indicator of its aliveness, as supported by Wenger et al. (2002b). By producing regular content and promoting interactions, we promote a beat, a sense of life and energy associated to the platform. If there is strong and rhythmic beat, "*the community has a sense of movement and liveliness. If the beat is too fast, the community feels breathless; people stop participating because they are overwhelmed. When the beat is too slow, the community feels sluggish*" (Wenger et al., 2002b, pp. 62-63).

Nevertheless, the few authors were supported and encouraged by peer feedback and a consumer audience, as Gee (2015) stated for the PAS. This support came from the feedback specific form and from the connected social networks, on the shape of likes, reactions or sharings (163 reactions), which contributed to the growth and to a dynamic participation of the spaces, as Lammers et al. (2012) defend on their expanded notion. After publishing content on social teachers' groups, the site views and visitors increased and the subsequent interactions allowed some of the articles to reach almost 2000 persons.

Still related to social networks and more specifically to teachers' social groups, we tend to agree with Lammers et al. (2012) as to the importance of these online portals in encouraging participation, instead of discussion panels, that functioned as key portals when the concept was developed.

Feedback provided also directs our opinion as to the fact that affinity spaces provide a passionate audience for content (Gee, 2015; Gee & Hayes, 2012), that participants can respond to, as active members or even future collaborators (Lammers et al., 2012).

2.2 Study 2 – Participation intention

Study 2 is aimed at identifying the beliefs of teachers associated with participation in the mCiências platform, and has therefore turned to TPB and associated methods.

According to the TPB, human behavior is conditioned by three factors – behavioral beliefs, normative beliefs and control beliefs. The first concerns the consequences of behavior, the second concerns the normative expectations of others, and the third, the presence of aspects that favor or hinder the performance of a certain behavior (Ajzen, 1991, 2006a, 2006b).

In turn, behavioral beliefs produce an attitude towards behavior; normative beliefs result from a subjective norm, and control beliefs result from a perceived behavioral control. The interaction between attitude towards behavior, subjective norm and perceived behavioral control results in an intention to perform a given behavior (Figure 2.7). This behavioral intention, which precedes behavior, will be all the greater as more favorable the attitude and greater the subjective norm and the perceived control (Ajzen, 1991, 2006a, 2006b).

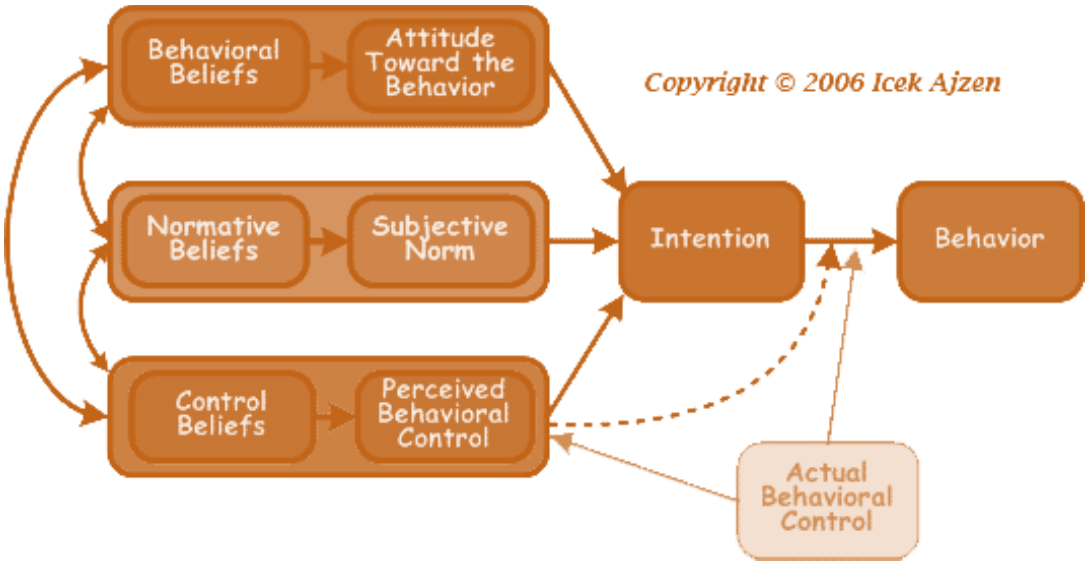


Figure 2.7. TPB model.

Therefore, based on the TPB, we propose to research the intention of participation (registration, sharing or comment on projects, practices or resources) on

mCiências Affinity Space by teachers, as well as the contribution of attitude towards behavior, subjective norm and perceived behavioral control, in this specific behavioral intention.

2.2.1 Methods

In this section, and as in the previous study, we will disclose information about participants, developed instruments and data analysis, which have been developed and applied in accordance with TPB guidelines.

2.2.1.1 Participants

Some participants were gathered from author acquaintances, but they were mainly gathered during three project presentation sessions developed at Faculdade de Ciências da Universidade do Porto (FCUP) for teachers who accompanied students participating in the Chemistry Olympiads. In these sessions, the teachers had the occasion to know the project, the platform developed and the free access repository. There was also an opportunity to know, use and explore augmented reality multimedia apps, like *Aurasma*, or multimedia tools, like *Kahoot!*, that can be used in science teaching practices.

The number of valid questionnaires collected and analyzed was 60. Of the 60 teachers involved, 52 are female and 8 are male, aged between 28 and 64 years old (M=47.00, SD = 7.56).

The clear majority of the teachers involved originated from the disciplinary group 510 – Física e Química [Physics and Chemistry] (N=46), followed by teachers from group 520 – Biologia e Geologia [Biology and Geology] (N=11), and small participation from group 110 – 1º Ciclo do Ensino Básico [1st Cycle of Basic Education] (N=2) and from group 500 – Matemática [Mathematics] (N=1). 12 of these teachers work in private schools and 35 of the public-school teachers have a tenure position at a given school.

Regarding academic qualifications, one is a graduate, 43 have a bachelor's degree and 15 have a master's degree, and only one has a PhD, however, only six participants present specific training in multimedia.

2.2.1.2 Instruments

In order to analyze intention, attitude, subjective norm and the perceived behavior we developed a questionnaire (Appendix B) based on the TPB. This instrument was designed to gather direct measures for these parameters as well as indirect measures, based on behavioral beliefs (behavioral outcomes, normative referents and control factors) and the evaluation of those beliefs' strengths (outcome evaluation, motivation to comply and power of control factors) (Ajzen, 2006a).

To elicit these beliefs, a prior free response questionnaire (Appendix C) was applied to a small sample of six individuals representative of the research population (Ajzen, 1991, 2006a, 2006b), in this case science teachers.

A content analysis of the personal beliefs allowed to determine the modal accessible beliefs in the population by counting the number of times a given response category had been emitted (Ajzen, 2006a, 2006b; De Leeuw, Valois, Ajzen, & Schmidt, 2015). The most frequent ones were used to develop the constructs for the final questionnaire, where the beliefs, as the belief strength, were inferred by means of a 7-point scale (for example, extremely good – extremely bad or agree – disagree) (Ajzen, 2006b).

The resulting questionnaire presents nine sections relative to different aspects of TPB and are interspersed. Section I consists of outcome evaluations items, section II refers to assessment of past behavior, section III consists of direct measures items, section IV consists of the motivation to comply items, section V consists of behavioral beliefs items, section VI consists of behavioral control items, section VII consists of perceived control beliefs items, and section VIII consists of normative beliefs items. Section IX includes measures of demographic characteristics considered of interest for the investigation, although anonymity of the participants was guaranteed throughout the

process. However, and to guarantee the existence of a unique identifier, that allowed the correspondence between intention and behavior of participation in the platform mCiências, participants were asked to provide the first five letters of their e-mail address.

The questionnaire also presented a cover providing the participants with all the necessary information for the application of this research instrument, since some of them accessed the questionnaire digitally.

Questionnaire data was collected at four different application moments – M1, M2, M3 and M4.

M1 comprises the questionnaires applied during "Olimpíadas de Química | Semifinal do Porto", which took place on March 11th at the Department of Chemistry and Biochemistry in FCUP. This sample only involved teachers from the disciplinary group 510 (Físico-Química).

M2 corresponds to questionnaires applied via google forms, sent by e-mail to teachers (acquaintances of the author) from different disciplinary groups.

M3 comprises the questionnaires applied during "Olimpíadas de Química Junior | Semifinal do Porto", which took place on April 22nd at the Department of Chemistry and Biochemistry in FCUP. This sample also involved only teachers from the disciplinary group 510 (Físico-Química).

M4 comprises the questionnaires applied during "Olimpíadas de Química Junior | Final Nacional", which took place on May 6th at the Department of Chemistry and Biochemistry in FCUP. This sample mainly involved teachers from the disciplinary group 510 (Físico-Química), since there was a minor presence of teachers from other disciplinary groups accompanying the students.

2.2.1.3 Data analysis

All missing values of indirect measures that do not invalidate the questionnaire have been replaced by the average value for that question. Items that had a negative

endpoint on the right were recoded so that high scores always represent a positive value relative to the parameter in study. This implies that a response of 7 becomes a response of 1, but a response of 4, associated to indifference, remains a 4 (Francis et al., 2004).

Descriptive statistics on the quantitative data collected were obtained using the SPSS statistical package (IBM Corp. Released 2016. IBM SPSS Statistics for Windows, Version 24.0. Armonk, NY: IBM Corp.).

The final values of the direct measures of attitude, subjective norm and perceived behavioral control were calculated through the mean of the values obtained in each of the respective items on Section III, so direct measures will still vary between 1 and 7, maintaining 1 as the most negative position and 7 as the most positive position (Francis et al., 2004).

Correlations between all measures were calculated using Spearman's correlation coefficient (ρ) (Paiva, Morais, Rosa, Moreira, & Eichler, 2017), and the items that provide direct measures of attitude, subjective norm, perceived behavioral control and intention were tested for internal consistency (Francis et al., 2004).

The direct measures were also subjected to a multiple regression procedure, being intention the dependent variable and the other direct measures the independent variables (Francis et al., 2004).

Indirect measures were obtained through multiplying each belief by its respective evaluation. The sum of the weighted beliefs creates a composite indirect value (Ajzen, 1991; Francis et al., 2004; Kim, Ham, Yang, & Choi, 2013), using the expectancy-value approach, where $\text{Atitude} \propto \sum_{i=1}^{n} BB_i \, OE_i$, $\text{Subjective Norm} \propto \sum_{j=1}^{n} NB_j \, MC_j$, and $\text{Perceived Behavioral Control} \propto \sum_{k=1}^{n} CB_k \, CF_k$ (Ajzen, 1991).

Internal consistency for beliefs was not calculated as there is no reason for them to be so, since a person can exhibit contradictory beliefs about a given behavior (De Leeuw et al., 2015).

As indirect measures result of a weighting through multiplication and sum, they do not fit the 7-point evaluation scale used in the questionnaire. For this, some reference

lines where created, by calculating the maximum and minimum value possible for each construct. For example, the maximum possible value for the attitude construct results from a belief strength of 7 multiplied by an outcome evaluation of 7. As there are 10 questions that contribute to this construct, the maximum value results of (7x7)x10 (Francis et al., 2004). The same reasoning was applied to the minimum value, as to the other scale points, on the different constructs (Table 2.6.), to qualify the contribution of the different constructs.

In order to identify which of the underlying beliefs would influence more the intention towards participation, linear regressions were applied using beliefs as independent variables and indirect measures constructs as dependent variables.

The qualitative data, originated by the open answer questions posed during the questionnaires, were submitted to a thematic analysis with an exploratory character.

Table 2.6. Reference Lines for the Indirect Measures Constructs.

Reference Line	*Attitude*	*Subjective Norm*	*Perceived Behavioral Control*
1	10	6	8
2	40	24	32
3	90	54	72
4	160	96	128
5	250	150	200
6	360	216	288
7	490	294	392

2.2.2 Results

The questionnaire based on TPB was first analyzed descriptively, retrieving the means and standard deviations for answers formulated by the seven-point concordance scale. Table 2.7 shows these results and the Spearman correlation coefficient (ρ) between direct and indirect measures, intention and past behavior.

Table 2.7. Means, standard deviations and correlations between all variables.

Variable	*N*	*Mean*	*SD*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*
1. Intention	60	4,93	1,78	-	**,307***	**,542****	**,794****	**,275***	,046	,074	**,287***
2. Attitude DM	60	5,40	1,26		-	**,290***	**,400****	**,324***	-,069	,151	-,090
3. Subjective Norms DM	59	5,06	1,11			-	**,489****	**,317***	**,381****	,141	,035
4. Perceived Behavioral Control DM	60	4,90	1,55				-	,215	,045	,003	,233
5. Attitude IM	60	265,04	37,76					-	,228	**,400****	-,036
6. Subjective Norms IM	60	111,87	56,61						-	,148	-,042
7. Perceived Behavioral Control IM	60	246,12	49,90							-	,106
8. Past Behavior	59	2,88	2,30								-

. The correlation is significant at the 0.05 level (bilateral).
****. The correlation is significant at the 0.01 level (bilateral).***

On Table 2.8 can be seen the Cronbach's alfa (α) relative to the internal consistency of the direct measures of attitude, subjective norms, and perceived behavioral control.

Table 2.8. Direct Measures Cronbach's alpha(*α*).

Direct Measure	*A*
Attitude	,325
Subjective Norms	,675
Perceived Behavioral Control	,593

The frequency distribution of the direct measures value on the 7-point scale can be seen on Table 2.9, being 1 the most negative endpoint and 7 the most positive endpoint. As the final values of the direct measures of attitude, subjective norm and perceived behavior control were calculated through the mean of the values obtained in each of the respective items on section III, there are some intermediate values which were also reported in the table. Figure 2.8 to Figure 2.11 also represent this frequency distribution in the form of a chart, for an intuitive reading, allowing to see that the options selected by participants in study 2 for all the direct measures are mainly on the positive spectrum of the seven-point scale.

Table 2.9. Frequency distribution of the direct measures value.

Value	*Intention*		*Attitude*		*Subjective Norm*		*Perceived Behavior Control*	
	N	*%*	*N*	*%*	*N*	*%*	*N*	*%*
1,0	5	8,3	-	-	-	-	1	1,7
1,5	-	-	-	-	1	1,7	1	1,7
2,0	2	3,3	-	-	1	1,7	3	5,0
2,5	-	-	-	-	-	-	2	3,3
3	5	8,3	1	1,7	1	1,7	2	3,3
3,5	-	-	3	5,0	2	3,4	4	6,7
4	6	10,0	13	21,7	8	13,6	7	11,7
4,5	-	-	4	6,7	9	15,3	4	6,7
5	17	28,3	9	15,0	8	13,6	8	13,3
5,5	-	-	3	5,0	11	18,6	6	10,0
6	12	20,0	9	15,0	13	22,0	9	15,0
6,5	-	-	2	3,3	2	3,4	7	11,7
7	13	21,7	16	26,7	3	5,1	6	10,0
Total	**60**	**100%**	**60**	**100%**	**59**	**100%**	**60**	**100%**

Regarding the distribution of responses associated with direct measure of intention, it is possible to verify that the great majority has a positive intention, as 42 respondents (70.0%) selected an option equal or greater than five.

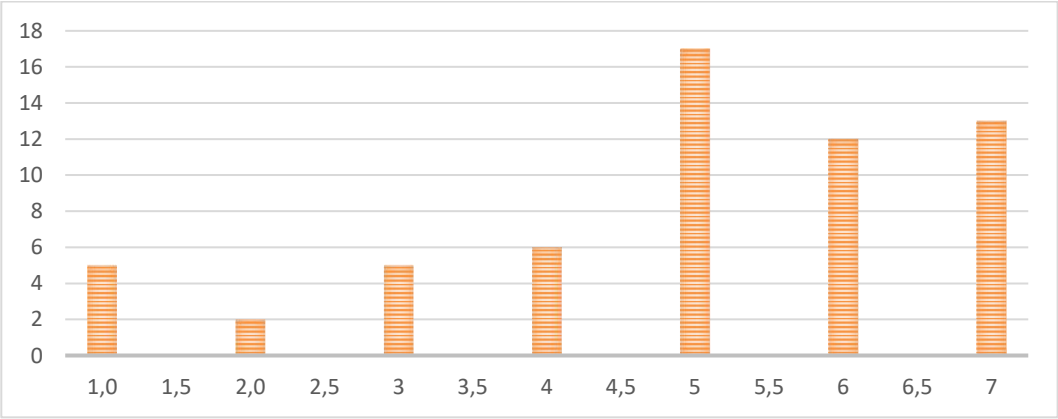


Figure 2.8. Intention direct measure histogram.

Attitude direct measure also reveals that the majority of respondents present a positive attitude towards participation on mCiências, as 39 of them (65.0%) selected an option equal or greater than five.

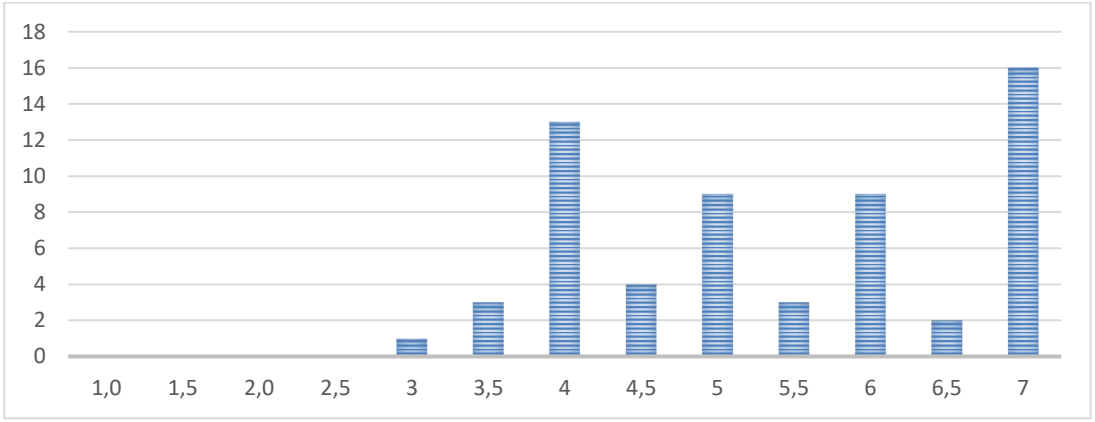


Figure 2.9. Attitude direct measure histogram.

Subjective norm direct measure follows the same pattern as 37 of the respondents (62.7%) selected an option equal or greater than five.

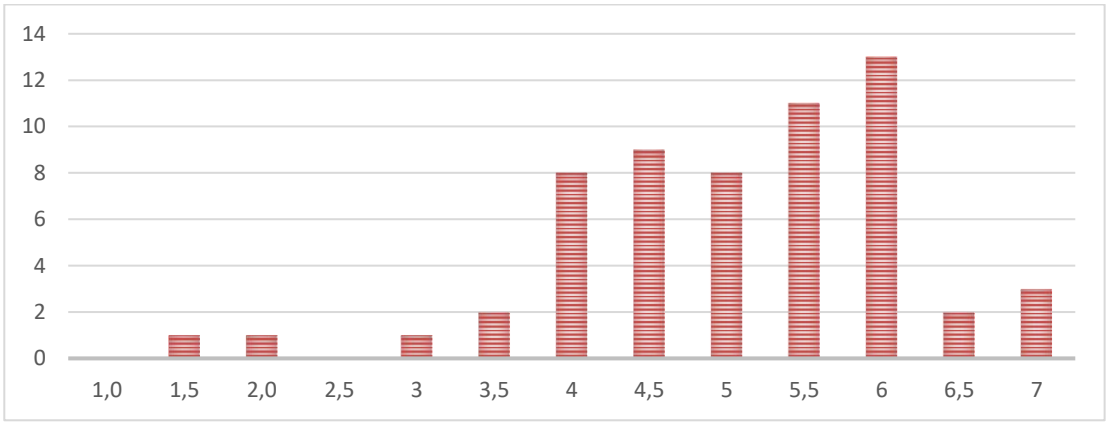


Figure 2.10. Subjective norm direct measure histogram.

Perceived behavior control direct measure, although presenting the same positive trend, this is not as expressive, since only 36 respondents (60.0%) have selected an option equal or greater than five.

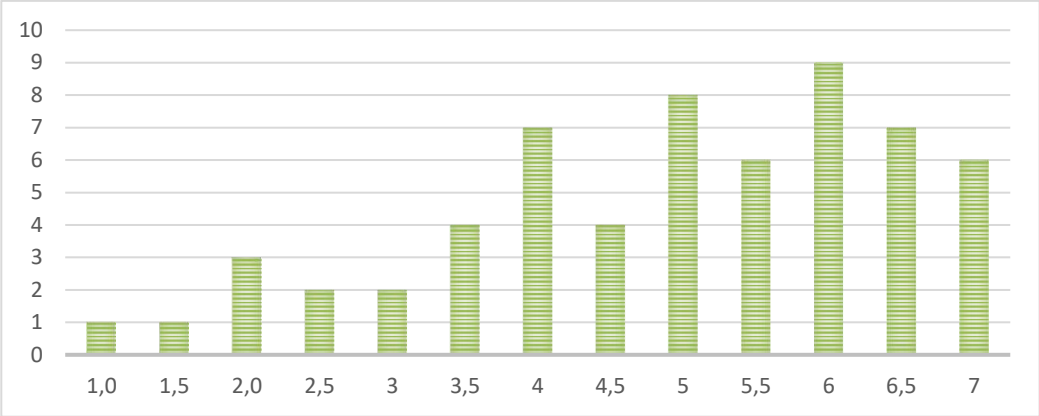


Figure 2.11. Perceived behavior control direct measure histogram.

Indirect measures frequency distribution can also be read under the 7-point scale, using the reference lines created, being 1 the most negative endpoint and 7 the most positive endpoint (Figure 2.12 to Figure 2.14).

The same positive trend observed above in the direct measures can be observed in the indirect measures, taking as a reference point the lines previously defined, mainly the one defined for an indifference position (reference line 4).

The indirect measure of attitude is presented here as extremely positive, since only one of the respondents has a negative attitude value (Figure 2.12).

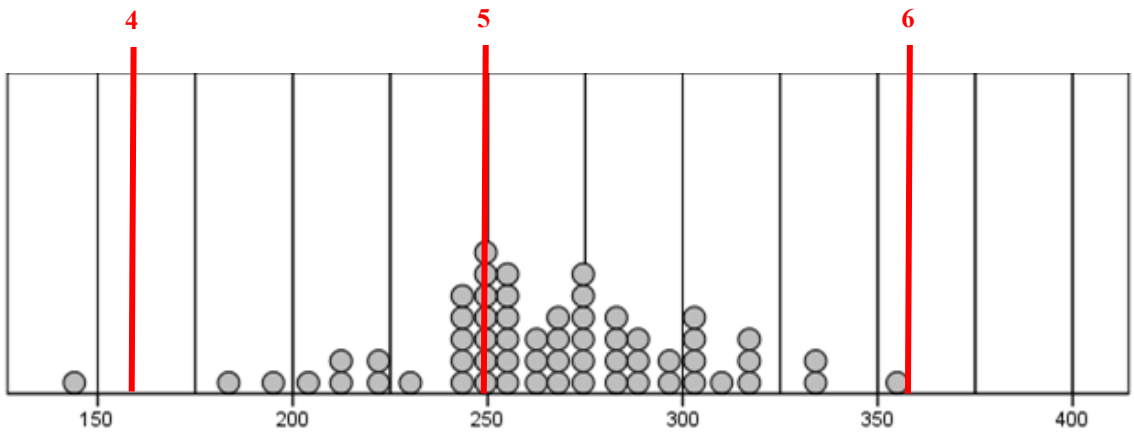


Figure 2.12. Attitude indirect measure distribution.

Subjective norm indirect measure distribution is a little more disperse, as can be seen on Figure 2.13, despite the higher number of respondents presented with a higher construct value than the reference value of 96 associated with a position of indifference.

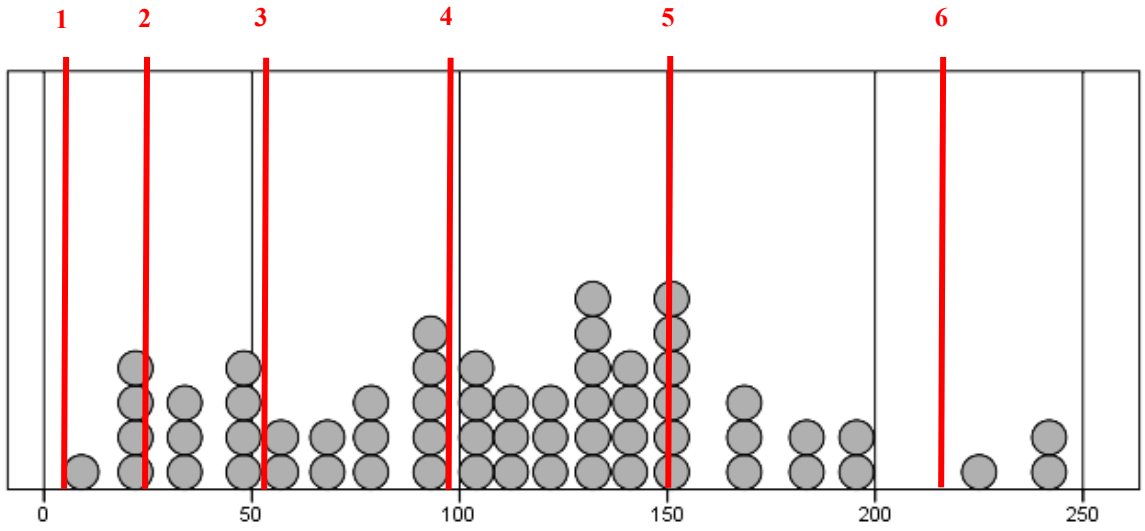


Figure 2.13. Subjective norm indirect measure distribution.

Perceived behavior control indirect measure also presents itself as extremely positive, as only one respondent is associated to a slightly negative construct value (Figure 2.14), under the reference line 3.

Using the values obtained for the direct and indirect measures, it was possible to calculate several multiple regression procedures, in order to predict models and to identify significant aspects related to the TPB factors and participants' beliefs.

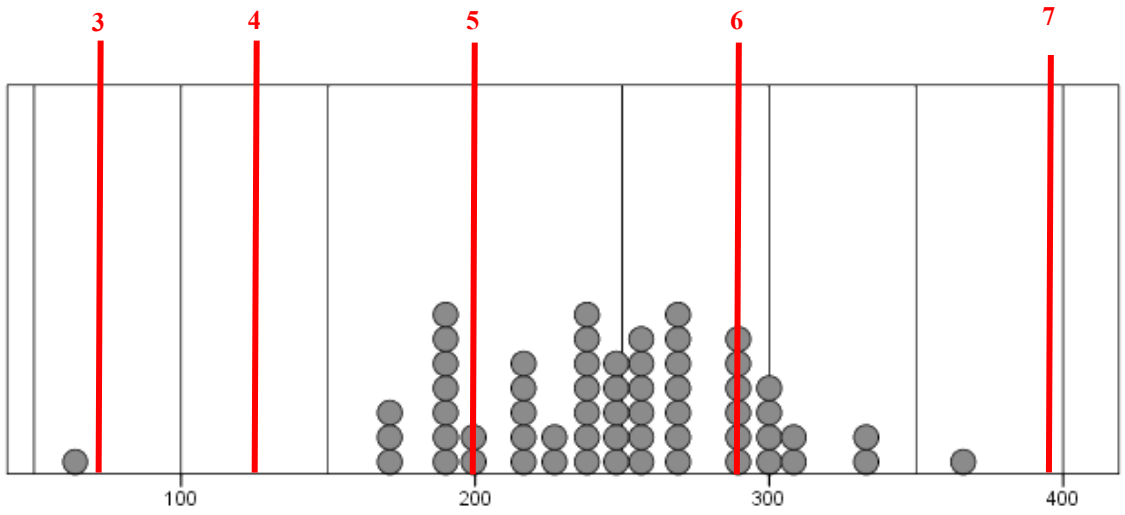


Figure 2.14. Perceived behavior control indirect measure distribution.

A multiple regression procedure was run to predict intention from the direct measures of attitude, subjective norm and perceived behavioral control (Table 2.10).

These variables statistically significantly predicted intention, F= 24,684, p < .005, R2 = 0.574, as the linear regression explains 57.4% of the variance in the data, despite only two variables (subjective norm and perceived behavior control) added statistically significantly to the prediction, p < .05.

Table 2.10. Linear regression Model – Dependent variable: Intention.

R	**R square**	**Adjusted R square**	**Standard deviation error of the estimate**	***F***	**Sig.**
,758	,574	,551	1,206	24,684	.000

Coefficients

Independent Variable	***Unstandardized coefficients***		***Standardized coefficients***	***t***	***Sig.***	***95,0% Confidence interval for B***	
	B	*Std. error*	*Beta*			*Lower Bound*	*Upper bound*
(Constant)	-,520	,897		-,580	,564	-2,319	1,278
Attitude	-,018	,135	-,013	-,135	,893	-,288	,252
Subjective Norm	,433	,162	,268	2,674	,010	,109	,758
Perceived Behavioral Control	,687	,120	,598	5,728	,000	,447	,927

The general form of the equation to predict intention from the other direct measures results as: *Predicted Intention = -0,520 – (0.18 x Attitude) + (0.433 x Subjective Norm) + (0,687 x Perceived Behavioral Control).*

As only two of the variables added statistically significantly to the prediction, and attitude presented a negative contribution, a new multiple regression procedure was run, using not the mean as the direct measure of attitude, but the original two values, corresponding to attitude 1 and attitude 2 (Table 2.11).

According to this new procedure, it was possible to determine a new equation to predict intention from the other direct measures results as: *Predicted Intention = -0,574 – (0.18 x Attitude1) + (0.024 x Attitude2) + (0.421 x Subjective Norm) + (0,687 x Perceived Behavioral Control).*

Table 2.11. Linear regression Model with attitude subdivision – Dependent variable: Intention.

R	R square	Adjusted R square	Standard deviation error of the estimate	F	Sig.
,758	,574	,543	1,217	18,196	.000

Coefficients

Independent Variable	*Unstandardized coefficients*		*Standardized coefficients*	*t*	*Sig.*	*95,0% Confidence interval for B*	
	B	*Std. error*	*Beta*			*Lower Bound*	*Upper bound*
(Constant)	-,574	,952		-,603	,549	-2,482	1,334
*Attitude 1**	-,018	,083	-,020	-,215	,830	-,184	,148
Attitude 2	,024	,194	,015	,126	,900	-,365	,414
Subjective Norm	,421	,176	,261	2,397	,020	,069	,778
Perceived Behavioral Control	,687	,130	,590	5,232	,000	,418	,938

**Recoded item.*

Although Attitude 1 and Attitude 2 didn't add statistical significance to the prediction, as p > ,05 and the linear regression still explaining 57.4% of the variance in the data, this new procedure showed that the sub-factor attitude 1 maintained a negative contribution to the establishment of an intention to participate, thus a new linear regression procedure was performed using only the values associated with item 2 of the direct attitude measurement (Table 2.12).

Table 2.12. Linear regression Model with only Attitude 2 – Dependent variable: Intention.

R	R square	Adjusted R square	Standard deviation error of the estimate	F	Sig.
,757	,574	,550	1,206	24,674	.000

Coefficients

Independent Variable	*Unstandardized coefficients*		*Standardized coefficients*	*t*	*Sig.*	*95,0% Confidence interval for B*	
	B	*Std. error*	*Beta*			*Lower Bound*	*Upper bound*
(Constant)	-,624	,915		-,682	,498	-2,458	1,209
Attitude 2	,014	,187	,009	,075	,940	-,360	,388
Subjective Norm	,427	,172	,264	2,474	,016	,081	,772
Perceived Behavioral Control	,687	,129	,590	5,275	,000	,420	,936

Using only Attitude 2 didn't add statistical significance to the prediction, as p >,05 for this independent variable, and, in fact, a linear regression procedure using a stepwise method would exclude at all the attitude as an independent variable (Table 2.13), with a resulting equation to predict intention from direct measures of *Predicted Intention = -0,586 + (0.431 x Subjective Norm) + (0,682 x Perceived Behavioral Control).*

Table 2.13. Stepwise Linear Regression Model – Dependent variable: Intention.

Model	R	R square	Adjusted R square	Standard deviation error of the estimate	F	Sig.
1 [a]	,720	,518	,510	1,260	61,334	,000
2 [b]	,757	,574	,558	1,195	37,678	,000

		Coefficients						
Model	**Independent Variable**	***Unstandardized coefficients***		***Standardized coefficients***	***t***	***Sig.***	***95,0% Confidence interval for B***	
		B	*Std. error*	*Beta*			*Lower Bound*	*Upper bound*
1 [a]	*(Constant)*	,885	,542		1,632	,108	-,201	1,971
	Perceived Behavioral Control	,828	,106	,720	7,832	,000	,616	1,039
2 [b]	*(Constant)*	-,586	,750		-,781	,438	-2,088	,916
	Perceived Behavioral Control	,682	,114	,593	5,992	,000	,454	,910
	Subjective Norm	,431	,160	,267	2,697	,009	,111	,752

a*. Predictors: (Constant), Perceived Behavioral Control*
b. *Predictors: (Constant), Perceived Behavioral Control, Subjective Norm*

To identify which of the underlying beliefs will have more influence on attitude towards participation, linear regressions were applied using beliefs as independent variables and indirect measure of attitude as dependent variable (Table 2.14).

It can be seen that beliefs identified by g) and h) don't present statistical significance, and beliefs identified by b), e), f), i) and j) have higher significance on predicting attitude.

Table 2.14. Linear regression Model – Dependent variable: Attitude indirect measure.

R	R square	Adjusted R square	Standard deviation error of the estimate	F	Sig.
,902	,813	,775	17,918	21,304	.000

Coefficients

Independent Variable	*Unstandardized coefficients*		*Standardized coefficients*	*t*	*Sig.*	*95,0% Confidence interval for B*	
	B	*Std. error*	*Beta*			*Lower Bound*	*Upper bound*
(Constant)	-57,752	22,884		-2,524	0,015	-103,739	-11,766
a) ... will help me share ideas, resources and practices.	-2,908	4,117	-0,070	-0,706	0,483	-11,182	5,365
b) ... will help me to innovate in school practices.	30,146	6,280	0,642	4,800	0,000	17,525	42,767
c) ... will help me in improving pedagogical practices.	-11,013	6,815	-0,249	-1,616	0,113	-24,709	2,683
d) ... will help me broaden my knowledge of the effectiveness of multimedia resources.	3,991	4,400	0,095	0,907	0,369	-4,852	12,834
e) ... will cause an accumulation of work.	4,097	1,329	0,213	3,083	0,003	1,426	6,768
f) ... may cause misuse of information.	4,863	1,922	0,197	2,530	0,015	1,001	8,726
g) ... will provoke resistance to change.	,797	1,821	0,035	0,437	0,664	-2,863	4,457
h) ... does not present me with any disadvantage.	,547	1,386	0,027	0,395	0,695	-2,239	3,333
i) ... will contribute to the improvement of learning.	14,817	5,855	0,300	2,530	0,015	3,050	26,583
j) ... will contribute to the dissemination of resources in my subject area.	11,543	5,502	0,248	2,098	0,041	0,487	22,599
k) ... will help me share ideas, resources and practices.	-2,908	4,117	-0,070	-0,706	0,483	-11,182	5,365

The same procedure was done to identify underlying normative beliefs and control beliefs to subjective norm and perceived behavioral control (Table 2.15 and Table 2.16).

Regarding the beliefs that have the highest statistical significance in the prediction of the subjective norm, we can indicate those represented by b) and d), as those represented by a) and e) do not present statistical significance.

Table 2.15. Linear regression Model – Dependent variable: Subjective norm indirect measure.

R	R square	Adjusted R square	Standard deviation error of the estimate	F	Sig.
,821	,674	,637	34,104	18,256	.000

Coefficients

Independent Variable	*Unstandardized coefficients*		*Standardized coefficients*	*t*	*Sig.*	*95,0% Confidence interval for B*	
	B	*Std. error*	*Beta*			*Lower Bound*	*Upper bound*
(Constant)	-20,675	15,425		-1,340	,186	-51,614	10,265
a) My superiors think I …	-,780	3,406	-,028	-,229	,820	-7,612	6,052
b) My students think I ….	8,515	3,968	,275	2,146	,036	,557	16,473
c) My colleagues think I …	7,179	4,287	,218	1,675	,100	-1,419	15,776
d) My students' educators think that I …	9,279	4,613	,279	2,011	,049	,026	18,532
e) The scientific community thinks that I …	2,542	4,960	,076	,513	,610	-7,406	12,490
f) Pre-service teachers think that I …	5,552	5,744	,156	0,967	,338	-5,969	17,073

For the beliefs that have the greatest statistical significance in the prediction of perceived behavioral control, we can indicate those represented by d), f), g) and h), while that represented by e) is the only one that does not present statistical significance, although belief c) has a very low significance level as it is very close to the limit of 0.5 defined to *p*.

Past behavior on the participation in an affinity space for teachers on the use of multimedia in science education in the last 6 months was also surveyed through a seven-point scale question. The responses histogram can be seen in Figure 2.15.

Past behavior presents a mean low value (N=59, M=2.88, SD = 2.30), and only eight respondents (13,56%) selected the most positive option (strongly agree) regarding their participation on such an affinity space.

Table 2.16. Linear regression Model – Dependent variable: Perceived behavioral control indirect measure.

R	R square	Adjusted R square	Standard deviation error of the estimate	F	Sig.
,877	,768	,732	25,831	21,151	.000

Coefficients

Independent Variable	*Unstandardized coefficients*		*Standardized coefficients*	*t*	*Sig.*	*95,0% Confidence interval for B*	
	B	*Std. error*	*Beta*			*Lower Bound*	*Upper bound*
(Constant)	-30,979	40,962		-,756	,453	-113,214	51,257
a) How often do you use websites with ease of information?	4,780	3,377	,125	1,416	,163	-1,999	11,560
b) How often do you share ideas, practices and knowledge?	5,036	3,190	,136	1,578	,121	-1,369	11,441
c) How often do you have an interest and willingness to learn?	6,743	8,304	,081	,812	,421	-9,928	23,415
d) How often do you participate in projects when you receive incentives and are motivated?	8,253	2,462	,269	3,353	,002	3,311	13,196
e) How often do your activities interfere with your occupation?	1,286	2,978	,042	,432	,668	-4,692	7,264
f) How often do you engage in time consuming activities?	9,457	3,560	,268	2,657	,011	2,310	16,604
g) How often does your practice of using multimedia resources in science education interfere with your plans?	6,857	2,291	,230	2,993	,004	2,257	11,458
h) How often does your family life make it difficult for you to participate in other activities?	9,976	2,095	,356	4,762	,000	5,770	14,181

It should be noted that, of the 59 participants, 29 (49,15%) selected the most negative option (strongly disagree).

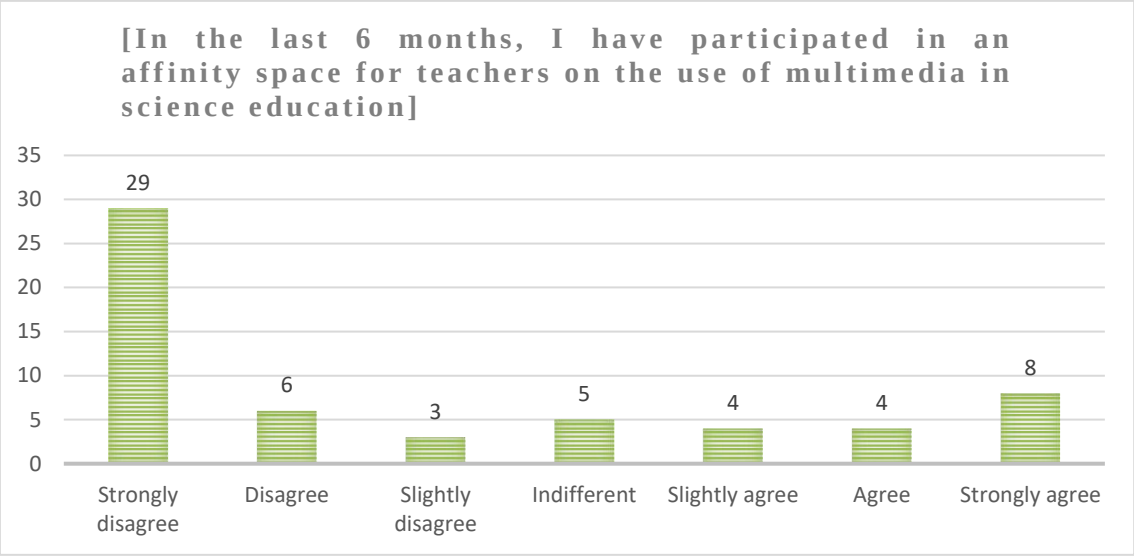


Figure 2.15. Past behavior.

The actual observed behavior of registration can be seen on Figure 2.16, with a total of 10% (N=60) of registered respondents on the subsequent month after the questionnaire's application.

Figure 2.16. Actual observed behavior of registration on mCiências.

Only one questionnaire presented qualitative data, originated by a comment related to the need to publicize the project: "*Has this project been conveniently disclosed? How come I've never heard of it, if I am a teacher interested in the subject?*".

2.2.3 Discussion

According to the TPB, intention of participation in the platform precedes the behavior, and will be all the greater as more favorable the attitude and greater the subjective norm and the perceived behavioral control (Ajzen, 1991, 2006a, 2006b).

Although our direct measures results show a low positive mean intention (4,93) of the group to participate on mCiências affinity space, the majority of the respondents (70.0%) have an intention direct measure value equal or greater than five. The same reasoning can be done to the values of perceived behavioral control as it has mean value of 4,90 and 60.0% of the respondents have a perceived behavioral control direct measure value equal or greater than five. Attitude and subjective norms direct measures present equally high percentage of respondents, respectively 64,9% and 62,7%, with final value equal or greater than five, although their mean values are above five.

Attitude is the only direct measure that shows no internal consistency, and with multiple items we may even drop one or two to increase internal consistency (Ajzen, 2016), but this is not the case, as there were only used two items to evaluate each direct measure, reflecting poor construction of this particular measure. These findings can have a simple explanation related to the questionnaire construction, as the item associated to sub-factor attitude 1 had an inverse order, being 1 the most positive result and 7 the most negative result, differing from the questions above and below. This was made undeliberately but may have caused some unintentional negative responses. Another aspect that seems to confirm this explanation is the fact that from the 6 respondents that have in fact registered in mCiências, 2 evaluate the future participation on the platform as slightly unpleasant, what is incoherent.

From the analysis of the results of the linear regression procedures it is possible to verify that the attitude does not contribute with statistical significance and is in fact, whatever the case, the factor with less contribution in the calculation of the intention. This is not a problem as there is no requirement on the TPB that each one of the direct measures makes a significant contribution to predict intention (Ajzen, 2016). In normal circumstances, this lack of predictive validity indicates that attitude simply does not contribute to the prediction of intention of participation in the mCiências platform.

On the other hand, we can state that perceived behavioral control has a strong effect on intention, being the most relevant factor in defining this factor, what is in accordance with the TPB, as these two are the immediate antecedents of the behavior.

According to the TPB, there should be significant correlations between direct and indirect measures, and there is a positive correlation between attitude and subjective norm direct and indirect measures, although the same cannot be said about perceived behavioral control. Direct measures also correlate more strongly with intentions than with past behavior.

Taking as reference the significance value $p < .05$, it can be seen that not all underlying beliefs play an influential role in participation in mCiências. There are underlying behavioral beliefs for participation in mCiências whose statistical significance is superior. These are related to innovation in teaching practices, improved learning and dissemination of discipline-specific resources, as well as accumulation of work and misuse of information. It is added here the importance of the standardized coefficient *Beta* as, the greater its value, the greater the impact of the belief on the attitude towards participation in mCiências space.

The most significant normative beliefs are related to the opinion of the students and their families or educators, being, at the opposite end of the spectrum, the hierarchy's opinion the least significant.

In the case of control beliefs, motivation and incentives, time-consuming activities, family life and practice on the use of multimedia resources are the most significant beliefs.

Since the intention to participate will increase, the more favorable the attitude, the subjective norm and the perceived behavioral control; the future actions to maximize the actual participation behavior in the platform must be centered or directed to the specific beliefs that present themselves as more significant or with higher impact on those factors.

Regarding this participation behavior, there is a low level of registration, as only 10% of the respondents registered on the platform, but only 27,12% of the respondents presented a positive past behavior of participation, and from those only 13,56% selected the strongly agree option when confronted with the affirmation of participation in an affinity space for teachers on the use of multimedia in science education, in the last 6

months. The low level of registration is consistent with what was already stated by several authors as referring to CoPs and affinity spaces – they are not easy to build and maintain, as all proper features must be in place (Gee, 2013; Gee & Hayes, 2012; Polin, 2010; Wenger & Snyder, 2000).

The optional space for the respondents to present any observations they deem important highlighted the need to project disclosure, as there are people interested in this subject that are unaware of its existence and would benefit from it.

2.3 Study 3 – Participation and platform interaction

By allowing diverse different ways to participate, interaction responses are also diverse, as not all participants in the previous studies showed the same level of engagement and interaction with the mCiências platform, with some of them taking a more active role, while others did not, thus distancing themselves from the register behavior identified as a clear sign of participation. In this third and last study, efforts were made to understand the different types of interaction as to clarify participants' perceptions about their own participation. Therefore, some participants associated with different levels of involvement and participation in the platform were selected to be the target of an open response questionnaire, to which a subsequent thematic analysis was applied.

2.3.1 Methods

In this section, we will address and identify the different typologies of interaction that have been perceived in our group of participants, as well as the instruments constructed and the associated data analysis carried out on study 3.

2.3.1.1 Participants

In order to select possible participants for this study, four groups (A, B, C and D) were defined according to the interaction shown. Interactions range from only at the level of social networks (group A), an interaction of sharing and dissemination of works as holders of the author position in the platform (group B), a failed interaction since the dissemination of the works developed did not occur (Group C) and, finally, no interaction, either at the platform level or at the level of social networks (group D). The types of interaction mentioned and the associated group designation can be seen in Table 2.17.

After clarifying these groups, nine participants were selected from the previous studies to participate in the current study.

Table 2.17. Interaction type and group identification.

Group	Interaction
A	*Social Networks*
B	*Authors*
C	*Unsuccessful*
D	*No interaction*

2.3.1.2 Instruments

At this stage, four simple questionnaires were developed, to clarify some perceptions about the platform, as well as the participation notion and to define future improvement strategies.

A total of six open answer questions were developed, differently distributed through the four questionnaires (Table 2.18). Five questions intended to gather information about the perception of actual participation and about future participation, the possibility of advising fellow science teachers to participate and the reasons for not sharing work on the platform, as well as the reasons for not having registered. The sixth and last question, common to all the questionnaires, pointed to the identification of improvements that could be implemented in the future development of the platform.

Table 2.18. Open answer questions developed for study 3 questionnaires.

Questions	Group
▪ Tell us a little bit about your interaction with the mCiências platform.	**A | B | C | D**
▪ How do you envisage your future participation in the platform? Why?	**A | B | C | D**
▪ What would you say to a disciplinary department colleague about the platform? Would you advise him/her to participate?	**A | B | C | D**
▪ Could you indicate the reason(s) for not disclosing your work(s) on the platform?	**A | C | D**
▪ Could you indicate why you did not register on the platform?	**A | D**
▪ What improvement suggestions would you like to leave?	**A | B | C | D**

The four questionnaires differ mainly in the number of questions, mainly due to the different typology of interaction defined previously. Thus, the questionnaire applied

to group A has more questions than that applied to group B, since the latter does not have to question the reason for not having registered on the platform.

2.3.1.3 Procedures

The constructed questionnaires using google forms where made available to the four groups of people, according to their interaction with the platform and by means of a link included in an electronic message sent to each of the selected elements requesting their participation. The anonymity of the participants, as in the previous study, was guaranteed throughout the process. Questionnaires can still be accessed using the shortlinks in Table 2.19.

Table 2.19. Short links to questionnaires used on study 3.

Link	Questionnaire
https://goo.gl/EQSLR9	**A**
https://goo.gl/xdrEbx	**B**
https://goo.gl/xMC7PU	**C**
https://goo.gl/At3Ebk	**D**

2.3.1.4 Data analysis

The qualitative data, originated by the open answer questions posed on the online questionnaires, were collected through the *google sheets* generated by the respective *google form* used to apply the questionnaires. After all the answers were gathered, the thematic analysis with an exploratory character was carried out, identifying the main idea present in each one of the answers to the different questions.

2.3.2 Results

Only five respondents submitted the questionnaire, and from those who submitted none of them was from group C, that represented unsuccessful interaction. The thematic analysis of the answers given by the respondents' groups (A, B and D) is shown on Table 2.20.

Table 2.20. Study 3 questionnaire thematic analysis.

Answers	**Question**			
	Tell us a little bit about your interaction with the mCiências platform.			
	A1	Low; Intention to increase.	A2	Repository exploration.
	B1	Dissemination point; Knowledge sharing point.	B2	Curiosity; Work disclosure as invited researcher.
	D	Sharing point.		
	How do you envisage your future participation in the platform? Why?			
	A1	Update/reflexion on multimedia. Assistance in the teaching / learning process.	A2	Works exploration. Work dissemination.
	B1	Work dissemination. Multimedia developments information.	B2	Multimedia developments information. Future work dissemination.
	D	Active, because sharing improves teaching.		
	What would you say to a disciplinary department colleague about the platform? Would you advise him/her to participate?			
	A1	Relevant tools/suggestions for classroom. Yes.	A2	Sharing encouragement. Yes.
	B1	Importance of community platforms; Promotion of techniques and tools beneficial for students and teachers. Yes.	B2	Promotion of educational tools for teachers and students; Direct research; Foster collaboration and discussion among stakeholders. Yes.
	D	Useful classroom resources; Information update. Yes.		
	Could you indicate the reason(s) for not disclosing your work(s) on the platform?			
	A1	Lack of relevant works.	A2	Lack of time.
	D	Ethic reasons; Works involving third parties; Monetarily involved research.		
	Could you indicate why you did not register on the platform?			
	A1	Misunderstanding (Thought it was exclusive to College Students).	A2	Lack of time.
	D	Wrongly thinking to be registered.		
	What improvement suggestions would you like to leave?			
	B2	Maximum dissemination of the platform through different channels and means; Clear statement of objectives and benefits to the target audience.		
	D	Find ways to reach more people that are not connected to the university.		

When discussing their interaction with the platform, it is clear from the answers obtained in group A that for them it was reduced or low, and in one case it was merely exploratory. However, it is also evident the willingness of one of the group A respondents to increase interaction in the future, a desire accompanied by the expectation of a more active future participation demonstrated by the respondent of group D.

Respondents, when describing past interaction or prospecting future interaction, apply very similar terms and ideas, mainly in terms of dissemination and disclosure of their own or educationally relevant works to the teaching community. The same is true to the classification of the platform as a point of information attainment on multimedia trends for teaching, as well as a space of discovery of tools or strategies to apply in the classroom, in real situations.

All the respondents would advise a colleague STEM teacher to participate, mainly by all the reasons given above, but also to promote collaboration and to direct multimedia research.

The lack of relevant works, time and ethic reasons or not the full ownership of the works were some reasons pointed by respondents of group A and D for not disclosing their own work on the platform.

Time seems to be relevant for the absence of registration on the platform, as some misconceptions, like an erroneous idea that the platform would be exclusive for university students or the thought that they are effectively already registered as users.

Improvement suggestions refer the need of clarification of the project objectives and benefits to the target audience, as to the need of reaching and gathering more participants, through different channels and means of dissemination.

2.3.3 Discussion

According to the data, it is possible to verify that, when faced with a short description of past and future interaction with the platform mCiências, respondents refer terms like sharing, disclosure and dissemination that are in accordance with our purpose of knowledge sharing and exchange between the affinity community members, to reduce the gap between researchers and teachers.

Throughout the answers to the different questions it is noticeable a consistency in the image of the platform, its objectives and functions as a space for sharing experiences, practices and knowledge associated with the use of multimedia in science teaching.

In addition to this, a unanimous advice of participation to other teachers validates the relevance of a platform like the one that was developed, as well as the importance of an affinity community for multimedia on science teaching.

We also consider relevant the fact that social factors, as the contact with people with similar interests has never been referenced, but always the need for sharing and the need of community platforms, and the common endeavor of multimedia use on science teaching, meeting what Hayes and Gee (2010) stated for the affinity spaces.

It is also relevant to emphasize that, although the group A and D respondents did not register, they consider that there was participation in the platform, which may imply that the notion of participation for these teachers is broader than the notion of participation used in the present work – an active participation through register and/or the share or comment on projects, practices or resources.

Regarding the sharing of own works, some ethical reasons have been presented and should be considered, such as the fact that the work may not have been performed by a single author, not owning it alone or being able to share it without authorization of all the authors involved in its development. The idea of a lack of relevant works to disseminate points the majority of consumers versus the minority of producers aspect associated with the affinity spaces as backed by Gee (2015).

Factors that lead to a lack of record should be considered in future research or developmental stages, highlighting the platform's advantages by reducing time-consuming activities related to multimedia use in science teaching activities, and also to avoid misunderstandings on the target audience and the registration itself.

As there were only respondents from groups A, B and D, this does not allow the generalization of these findings to the group C sample, associated with unsuccessful dissemination of works.

3. General Discussion

In this work we intended to reflect and evaluate the strategies implemented to generate a sustainable participatory community of peers on science education using multimedia, based on an expanded notion of affinity spaces with some CoP characteristics, presented by Lammers et al. (2012), thus contributing to the reduction of the gap between researchers and teachers. To do so, we used an action research methodology and resorted as well to Ajzen (1991) Theory of Planned Behavior, in order to complement our research with data about the STEM teachers' participation behavior in the affinity space.

The results of this work confirm the applicability of such syncretic notion between two social learning systems – affinity spaces and CoP, and validate our actions to establish a community of science teachers, guided by a common endeavor and not social aspects, thus allowing knowledge sharing and the dissemination of best practices.

Knowledge sharing, work dissemination and update of information to improve real, day-to-day teaching activities are some of the aspects that are associated by users to the interaction with the platform, thus in the future contributing to reduce the gap between academic production and pedagogical practice in the national panorama, associated with multimedia use on science teaching.

Participants could produce or consume content, although, as seen in other affinity spaces, most participants in a given space are consumers and the minority are producers.

We highlight the importance of providing the community with external expertise subject specific content, capable of attracting new elements, and thus contributing to the progressive development of an active community of peers, that provide feedback in a variety of ways, but mostly through the existing social networks, replacing the old forums.

Some correspondences can obviously be traced to Wenger et al. (2002a) development stages of a community. After an initial phase of defining the potential of the community, we overcame a coalescing stage, where, through events of dissemination and official launch of the platform, we extended the community to new members, reaching a phase of maturity of the mCiências space.

Although socialization is not the main reason of entry into the space, social networks present themselves as fundamental dynamic portals in the access to the affinity spaces. The mCiências space expanded, widening to more and more participants, simultaneously allowing different levels of participation and interaction, sometimes evading the strict notion of active participation defined initially as register, and/or the share or comment on projects, practices or resources.

In fact, the active participation behavior through a register was reduced, although the mean values for attitude, subjective norm and perceived behavioral control were moderately positive, thus indicating a positive participation intention that didn´t reflect itself on an actual behavior.

The most significant behavioral beliefs are associated with teaching and learning; similarly, most significant normative beliefs refer to the students and educators' opinions. Students' opinion is presented in the studies as a relevant normative belief, as happened with Paiva (Paiva et al., 2017), demonstrating here a participation intention directed to the student learning. Results of study 3 validate this student learning concern, as the improvement of teaching and learning is cited by different respondents.

At the level of normative beliefs, it is visible the devaluation of the opinion of hierarchical superiors, being the belief that presents less statistical significance and less

contribution to the subjective norm indirect measure, being this a curious event since hierarchical superiors also represent stakeholders and are active and fundamental elements of the educational community. However, belonging to a community may not necessarily be the same as belonging to a community like the one we want to develop here, as referenced by Wenger et al. (2002b) to CoP, since teachers may see them as external elements or someone who does not share the common endeavor, due to their management role and absence from school teaching activities.

The same seems to happen with the opinion of the scientific community, one of the groups whose present work intends to approach to science teachers; nevertheless, the opinion of the newly formed professors is already shrouded in significance. This seems a bit contradictory, as these new teachers were the teachers who had a more recent contact with the academy and who logically had access to the most recent developments in the use of multimedia in science education, having been influenced most recently by them. However, there is a considerable difference in significance between the belief associated to the opinion of these different stakeholders.

Our results confirm, however, that perceived behavioral control is the most significant factor on predicting participation intention, what is in sync with the verified by Paiva et al. (2017) when applying a TPB questionnaire to chemistry teachers about the future use of ICT. Perceived behavioral control is of most importance as it can, together with intention, influence the actual behavior.

Perceived behavior control most significant beliefs, on the other hand, are related to motivation and incentives, time consuming activities, family life and the practice on the use of multimedia resources. These concerns about time also relate with the findings on study 3, as it is a factor associated to participation on mCiências.

Future actions to maximize participation behavior on the platform should be carefully designed to act upon the most significant underlying beliefs, mainly the ones that act upon perceived behavioral control, thus amplifying the intention to participate in such an affinity community like mCiências.

Lammers et al. (2012) included socialization as an important point on the construction of the community within the affinity space, but there seem to be some more characteristics associated with CoP influencing the nature, genesis and development of a community within a space.

Common endeavor is the main factor around which the affinity space revolves, a dynamic place accessed by multiple multimodal portals allowing a diversified participation by a heterogeneity of actors. The notion of participation in these spaces should be broadened, since the production of content is reduced, however, social communication is high, through personal connections between the different participants, notoriously facilitated by social networks.

As for the establishment of a CoP, it is necessary a public presentation, an invitation to discover the space, an invitation made to stakeholders already involved in the endeavor in question, either physically presenting the space or using existing affinity spaces with related endeavors.

Although the affinity space is dynamic and anyone can enjoy its advantages, entering and leaving when desired, the same was not true for a CoP, which made a clear distinction between who was in and who was outside the community. In this process, the data collected through study 2 show that, although everyone can enter, not all may be seen in the same way, existing here a thin porous belief border controlling community status.

Thus, we do not consider that the application of an expanded notion terminology is adequate, but rather a new affinity community terminology given the coexistence of determinants of both aspects in the development of a community.

4. Conclusions

During this work, we established the ground for the genesis and the sustainable development of a community – an affinity community that arises around the multimedia use in science teaching. Through a syncretic notion between CoP and affinity spaces, it was possible to establish bridges between researchers and science teachers and, therefore, to enable future improvements of practice through links with research.

Such affinity community allows open access to knowledge and presents itself as dynamic, heterogeneous and multimodal, but also dependent on social factors to ensure its growth.

Identifying the main underlying beliefs allows the development of future lines of action, aimed to act on these specific and meaningful beliefs, like actions that privilege the dissemination of mCiências participation as a non-time consuming activity and not interfering with other activities, such as family activities.

Acting on the subjective evaluation of a belief, mainly on increasing the subjective evaluation of control beliefs, will thereby predictably increase the intention to participate and increase the behavior of STEM teachers' participation, thus ensuring further expansion and growth of the mCiências affinity community at this maturing phase.

4.1 Constraints and future work

There are some limitations and suggestions for future research that should be noted. Firstly, study 2 relies on a relatively small sample, and the data collection for TPB eliciting beliefs questionnaire on study 2, and for the questionnaires on study 3, comes from a convenience sample.

Secondly, the lack of internal consistency on the direct measure of attitude towards participation, indicating poor construction of this questionnaire item, may lead to an incorrect predicting model, although the main findings are associated with the significance of underlying beliefs of the indirect measures of attitude, subjective norm and perceived behavioral control, and not with this specific direct measure.

Future work will be needed on the evaluation of the capability of appropriating knowledge, generating scientific peer review and validation processes by the affinity community mCiências members, as this is still to be proven.

We hope that the results of this work can be taken into consideration when designing new national or international affinity communities to overcome the distance between researchers and teachers, thus enabling future transmission of learning innovations from research to educational practice, and allowing research findings to be incorporated into teacher preparation, as in curriculum development.

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Appendices

Appendix A – Facebook publications individual statistics

Date	Publication	Publication Reach	Interaction	
30-05-2017 10:12	http://spq-ffms.spq.pt/arquivo/1799	726	7 0 4	Reactions Comments Shares
23-05-2017 15:57	Quem já conhece este pequeno jogo sobre o controlo do ciclo celular?	337	2 0 1	Reactions Comments Shares
18-05-2017 22:41	MCiências adicionou um botão para te ajudar a saberes mais sobre a sua atividade.	35	3 0 0	Reactions Comments Shares
18-05-2017 12:21	Um vídeo 360º sobre a célula eucariótica.	62	3 0 0	Reactions Comments Shares
18-05-2017 11:29	MCiências partilhou o vídeo de Naked Geometry.	68	4 0 0	Reactions Comments Shares
16-05-2017 11:20	A Ordem dos Biólogos disponibiliza um conjunto de materiais escolhidos por uma equipa de professores e destinados a utilização em contexto de sala de aula.	68	5 0 0	Reactions Comments Shares
04-05-2017 18:27	Simulações e Laboratórios Virtuais.	1474	10 0 6	Reactions Comments Shares
04-05-2017 10:59	Uma tabela periódica interativa.	632	10 0 2	Reactions Comments Shares
28-04-2017 11:30	Já trabalhou com códigos QR?	875	8 0 7	Reactions Comments Shares
20-04-2017 22:32	Começa já no próximo dia 8 de maio a "X Conferência Internacional de TIC na Educação – Challenges 2017".	634	1 0 4	Reactions Comments Shares
11-04-2017 13:28	Recursos educativos digitais para a aprendizagem da Química através da Música - Venha conhecer o trabalho do Hugo Vieira.	1941	37 1 7	Reactions Comments Shares
08-04-2017 22:59	Conheça o trabalho da Ana Teixeira sobre "As infografias animadas no ensino das Ciências".	1897	46 2 9	Reactions Comments Shares
06-04-2017 12:35	Venha conhecer alguns dos projetos de investigação do Repositório que utilizam webquests!	25	2 0 0	Reactions Comments Shares
03-04-2017 19:12	Venha conhecer alguns dos projetos de investigação que utilizam o Geogebra!	409	3 0 2	Reactions Comments Shares
28-03-2017 13:58	http://spq-ffms.spq.pt/arquivo/1563	831	9 0 4	Reactions Comments Shares
23-03-2017 13:11	http://spq-ffms.spq.pt/arquivo/1536	265	4 0 1	Reactions Comments Shares
21-03-2017 16:23	http://spq-ffms.spq.pt/arquivo/1532	635	6 1 4	Reactions Comments Shares
16-03-2017 11:42	Venha conhecer alguns dos projetos de investigação recentemente adicionados ao Repositório.	36	2 0 1	Reactions Comments Shares
15-03-2017 13:46	Alguns momentos da sessão de 11 de Março 2017.	6	1 0 0	Reactions Comments Shares

Appendix B – TPB Final Questionnaire

Multimédia no ensino das ciências: espaço de afinidade para professores de ciências

(Mota, J., Morais, C., & Moreira, L., 2017)

Por favor, reserve alguns minutos para nos dizer o que pensa sobre a possibilidade de participar (registar-se, partilhar ou comentar projetos, práticas ou recursos) no espaço de afinidade de professores de ciências (mCiências, disponível em http://www.fc.up.pt/mciencias) sobre a utilização de multimédia no ensino das ciências durante o próximo mês.

***Não há respostas certas ou erradas**: estamos apenas interessados nas suas opiniões. Em resposta às perguntas abaixo, registe os seus pensamentos imediatos.*

Algumas das perguntas podem parecer semelhantes, mas elas abordam questões um pouco diferentes. Por favor leia cada pergunta cuidadosamente.

Todas as respostas a este questionário serão tratadas de forma completamente anónima. Muito obrigado pela sua colaboração!

Instruções.

Muitas das perguntas neste questionário recorrem a escalas de classificação com 7 pontos, onde deve selecionar o número que melhor descreve sua opinião. Por exemplo, se fosse convidado a classificar a afirmação "Para mim o clima do Porto é o melhor do país" numa escala deste tipo, os 7 pontos devem ser interpretados da seguinte forma:

Para mim o clima do Porto é o melhor do país

Discordo	1	2	3	4	5	6	7	Concordo
	discordo completamente	discordo muito	discordo ligeiramente	indiferente	concordo ligeiramente	concordo muito	concordo completamente	

Se concordar completamente com a afirmação deve circular o número 7.

Para mim o clima do Porto é o melhor do país

Discordo	1	2	3	4	5	6	(7)	Concordo
	discordo completamente	discordo muito	discordo ligeiramente	indiferente	concordo ligeiramente	concordo muito	concordo completamente	

Ao efetuar as suas classificações, por favor lembre-se dos seguintes aspetos:

- *Certifique-se de responder a todos os itens;*
- *Nunca circule mais de um número em cada escala.*

Parte I

1. Para mim, a partilha de ideias, recursos e práticas é

Extremamente má | | | | | | | Extremamente boa

2. Para mim, a inovação é

Extremamente má | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Extremamente boa

3. A melhoria das minhas práticas pedagógicas é

Extremamente má | | | | | | | | Extremamente boa

4. O aumento do meu conhecimento acerca da eficácia dos recursos multimédia é

Extremamente mau | | | | | | | | Extremamente bom

5. A melhoria das aprendizagens dos meus alunos é

Extremamente má | | | | | | | | Extremamente boa

6. A divulgação de recursos multimédia específicos da minha área disciplinar é

Extremamente má | | | | | | | | Extremamente boa

7. A acumulação do meu trabalho é

Extremamente má | | | | | | | | Extremamente bom

8. Para mim, a utilização indevida de dados ou conteúdos é

Extremamente má | | | | | | | | Extremamente boa

9. Para mim, provocar resistência à mudança é

Extremamente mau | | | | | | | | Extremamente bom

10. Para mim, a existência de desvantagens é

Extremamente mau | | | | | | | | Extremamente bom

Parte II

11. Nos últimos 6 meses, participei num espaço de afinidade para professores sobre a utilização de multimédia no ensino das ciências.

Discordo | | | | | | | | Concordo

Parte III

12. A minha participação no *mCiências* para professores de ciências no próximo mês seria

Agradável | | | | | | | | Desagradável

13. A minha participação no *mCiências* para professores de ciências no próximo mês seria

Prejudicial | | | | | | | | Vantajosa

14. Muitas pessoas importantes para mim considerariam relevante a participação no próximo mês no *mCiências*.

Discordo | | | | | | | | Concordo

15. Muitas pessoas como eu participariam no *mCiências* no próximo mês.

Discordo | | | | | | | | Concordo

16. Estou confiante que irei participar no *mCiências* no próximo mês.

Discordo | | | | | | | | Concordo

17. A minha participação no *mCiências* no próximo mês depende apenas de mim.

Discordo | | | | | | | | Concordo

18. Tenciono participar no espaço de afinidade *mCiências* no próximo mês.

Discordo ___|___|___|___|___|___|___ Concordo

Parte IV

19. Quanto à participação no *mCiências*, quero fazer o que os meus superiores pensam que devo fazer.

Discordo ___|___|___|___|___|___|___ Concordo

20. Quanto à participação no *mCiências*, quero fazer os que os meus alunos pensam que devo fazer.

Discordo ___|___|___|___|___|___|___ Concordo

21. Quanto à participação no *mCiências*, quero fazer os que os meus colegas pensam que devo fazer.

Discordo ___|___|___|___|___|___|___ Concordo

22. Quanto à participação no *mCiências*, quero fazer o que os Encarregados de Educação dos meus alunos pensam que devo fazer.

Discordo ___|___|___|___|___|___|___ Concordo

23. Quanto à participação no *mCiências*, quero fazer o que os futuros professores em formação pensam que devo fazer.

Discordo ___|___|___|___|___|___|___ Concordo

24. Quanto à participação no *mCiências*, quero fazer o que a comunidade científica pensa que eu devo fazer.

Discordo ___|___|___|___|___|___|___ Concordo

25. Em termos gerais, quão importante é para si o que a comunidade científica pensa relativamente à participação no *mCiências*?

Nada importante ___|___|___|___|___|___|___ Muito importante

26. Em termos gerais, quão importante é para si o que os seus superiores pensam relativamente à participação no *mCiências*?

Nada importante ___|___|___|___|___|___|___ Muito importante

27. Em termos gerais, quão importante é para si o que os seus alunos pensam relativamente à participação no *mCiências*?

Nada importante ___|___|___|___|___|___|___ Muito importante

28. Em termos gerais, quão importante é para si o que os seus colegas pensam relativamente à participação no *mCiências*?

Nada importante ___|___|___|___|___|___|___ Muito importante

29. Em termos gerais, quão importante é para si o que os encarregados de educação pensam relativamente à participação no *mCiências*?

Nada importante ___|___|___|___|___|___|___ Muito importante

30. Em termos gerais, quão importante é para si o que os professores em formação pensam relativamente à participação no *mCiências*?

Nada importante ___|___|___|___|___|___|___ Muito importante

Parte V

31. A minha participação no *mCiências* irá ajudar-me a partilhar ideias, recursos e práticas.

Discordo ___|___|___|___|___|___|___ Concordo

32. A minha participação no *mCiências* irá ajudar-me a inovar nas práticas letivas.

Discordo ___|___|___|___|___|___|___ Concordo

33. A minha participação no *mCiências* irá ajudar-me na melhoria das práticas pedagógicas.

Discordo ___|___|___|___|___|___|___ Concordo

34. A minha participação no *mCiências* irá ajudar-me a alargar o meu conhecimento sobre a eficácia dos recursos multimédia.

Discordo ___|___|___|___|___|___|___ Concordo

35. A minha participação no *mCiências* irá provocar uma acumulação de trabalho.

Discordo ___|___|___|___|___|___|___ Concordo

36. A minha participação no *mCiências* poderá provocar uma utilização indevida de informação.

Discordo ___|___|___|___|___|___|___ Concordo

37. A minha participação no *mCiências* irá provocar resistência à mudança.

Discordo ___|___|___|___|___|___|___ Concordo

38. A minha participação no *mCiências* não apresenta para mim qualquer desvantagem.

Discordo ___|___|___|___|___|___|___ Concordo

39. A minha participação no *mCiências* irá contribuir para a melhoria das aprendizagens.

Discordo ___|___|___|___|___|___|___ Concordo

40. A minha participação no *mCiências* irá contribuir para a divulgação de recursos da minha área.

Discordo ___|___|___|___|___|___|___ Concordo

Parte VI

41. Quão frequentemente utiliza *websites* que apresentem facilidade de informação?

Muito raramente ___|___|___|___|___|___|___ Muito frequentemente

42. Quão frequentemente partilha de ideias, práticas e conhecimento?

Muito raramente ___|___|___|___|___|___|___ Muito frequentemente

43. Quão frequentemente tem interesse e vontade em aprender?

Muito raramente ___|___|___|___|___|___|___ Muito frequentemente

44. Quão frequentemente participa em projetos quando recebe incentivos e é motivado?

Muito raramente ___|___|___|___|___|___|___ Muito frequentemente

45. Quão frequentemente as suas atividades interferem com a sua ocupação profissional?

Muito raramente ___|___|___|___|___|___|___ Muito frequentemente

46. Quão frequentemente se envolve em atividades que consomem muito tempo?

Muito raramente ___|___|___|___|___|___|___ Muito frequentemente

47. Quão frequentemente a sua prática no uso de recursos multimédia no ensino das ciências interfere com os seus planos?

Muito raramente ___|___|___|___|___|___|___ Muito frequentemente

48. Quão frequentemente a sua vida familiar dificulta a sua participação noutras atividades?

Muito raramente ___|___|___|___|___|___|___ Muito frequentemente

Parte VII

49. Se o *mCiências* apresentar facilidade de informação será muito mais fácil para mim participar.

Discordo ___|___|___|___|___|___|___ Concordo

50. Se o *mCiências* possibilitar a partilha de ideias, práticas e conhecimento, será mais fácil para mim participar.

Discordo ___|___|___|___|___|___|___ Concordo

51. Se eu tiver interesse e vontade em aprender será mais fácil para mim participar *mCiências*.

Discordo ___|___|___|___|___|___|___ Concordo

52. Se eu for incentivado e motivado será mais fácil participar *mCiências*.

Discordo ___|___|___|___|___|___|___ Concordo

53. Se a minha ocupação profissional exercer muita pressão será mais difícil para mim a participação no *mCiências*.

Discordo ___|___|___|___|___|___|___ Concordo

54. Se a minha participação no *mCiências* consumir muito tempo será mais difícil para mim a participação no espaço de afinidade.

Discordo ___|___|___|___|___|___|___ Concordo

55. A minha prática no uso de recursos multimédia poderá tornar mais difícil a minha participação no *mCiências*.

Discordo ___|___|___|___|___|___|___ Concordo

56. A minha vida familiar pode dificultar a minha participação *mCiências*.

Discordo ___|___|___|___|___|___|___ Concordo

Parte VIII

57. Os meus superiores pensam que eu deveria participar no *mCiências*.

Extremamente improvável ___|___|___|___|___|___|___ Extremamente provável

58. Os meus alunos pensam que eu deveria participar no *mCiências*.

Extremamente improvável ___|___|___|___|___|___|___ Extremamente provável

59. Os meus colegas pensam que eu deveria participar no *mCiências*.

Extremamente improvável ___|___|___|___|___|___|___ Extremamente provável

60. Os Encarregados de Educação dos meus alunos pensam que eu deveria participar no *mCiências*.

Extremamente improvável ___|___|___|___|___|___|___ Extremamente provável

61. A comunidade científica pensa que eu deveria participar no *mCiências*.

Extremamente improvável ___|___|___|___|___|___|___ Extremamente provável

62. Os futuros professores em formação da multimédia pensam que eu deveria participar no *mCiências*.

Extremamente improvável ___|___|___|___|___|___|___ Extremamente provável

Parte IX

Para efeitos de codificação, por favor, indique:

A. Ano de Nascimento: _____.

B. Sexo:
Masculino ☐ Feminino ☐

C. Habilitações académicas: _____.

D. Formação específica em Multimédia:
Sim ☐
Não ☐

E. Situação Profissional:
Docente Contratado ☐
Docente do Quadro de Zona Pedagógica ☐
Docente do Quadro de Escola ☐
Docente do Ensino Particular e Cooperativo ☐

F. Grupo disciplinar:
110 ☐ 230 ☐ 500 ☐ 510 ☐ 520 ☐

G. As <u>5 primeiras letras</u> do seu endereço de e-mail.

___|___|___|___|___

Se desejar receber atualizações sobre este projeto, por favor, indique o seu e-mail completo: _____

Registe no verso desta folha quaisquer observações que considere importantes. Por favor, verifique se respondeu a todas as questões. **Muito obrigado pela sua colaboração!**

Appendix C – Eliciting Salient Beliefs Questionnaire

Multimédia no ensino das ciências: espaço de afinidade para professores de ciências

(Mota, J., Morais, C., & Moreira, L., 2017)

Por favor, reserve alguns minutos para nos dizer o que pensa sobre a possibilidade de participar (registar-se, partilhar ou comentar projetos, práticas ou recursos) no espaço de afinidade de professores de ciências (mCiências, disponível em http://www.spq-ffms.spq.pt) sobre a utilização de multimédia no ensino das ciências durante o próximo mês.

***Não há respostas certas ou erradas**: estamos apenas interessados nas suas opiniões. Em resposta às perguntas abaixo, liste os seus pensamentos imediatos.*

Algumas das perguntas podem parecer semelhantes, mas elas abordam questões um pouco diferentes. Por favor leia cada pergunta cuidadosamente.

Todas as respostas a este questionário são completamente confidenciais. Muito obrigado pela sua colaboração!

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1. Quais as vantagens de participar *(registar-se, classificar, comentar e/ou partilhar ideias, projetos, práticas ou recursos)* num espaço de afinidade de professores sobre a utilização de multimédia no ensino das ciências durante o próximo mês?

a)
b)
c)
d)
e)
f)

2. Quais as desvantagens de participar *(registar-se, classificar, comentar e/ou partilhar ideias, projetos, práticas ou recursos)* num espaço de afinidade de professores sobre a utilização de multimédia no ensino das ciências durante o próximo mês?

a)
b)
c)
d)
e)
f)

3. O que mais lhe vem à mente quando pensa em participar *(registar-se, classificar, comentar e/ou partilhar ideias, projetos, práticas ou recursos)* num espaço de afinidade de professores sobre a utilização de multimédia no ensino das ciências?

a)
b)
c)
d)
e)
f)

Quando se trata da utilização do multimédia no ensino e da participação (registar-se, classificar, comentar e/ou partilhar ideias, projetos, práticas ou recursos) em espaços de afinidade de professores de ciências, pode haver indivíduos ou grupos que pensam que você deve ou não deve executar este comportamento.

4. Por favor liste os indivíduos ou grupos que aprovariam ou pensariam que você deveria participar *(registar-se, classificar, comentar e/ou partilhar ideias, projetos, práticas ou recursos)* num espaço de afinidade de professores sobre a utilização de multimédia no ensino das ciências.

a)
b)
c)
d)
e)

f)

5. Indique os indivíduos ou grupos que desaprovam ou pensam que você não deveria participar *(registar-se, classificar, comentar e/ou partilhar ideias, projetos, práticas ou recursos)* num espaço de afinidade/comunidade de professores sobre a utilização de multimédia no ensino das ciências.

a)
b)
c)
d)
e)
f)

6. Às vezes, quando não temos certeza do que fazer, procuramos ver o que os outros fazem. Por favor, liste os indivíduos ou grupos que são mais propensos a participar *(registar-se, classificar, comentar e/ou partilhar ideias, projetos, práticas ou recursos)* num espaço de afinidade de professores sobre a utilização de multimédia no ensino das ciências.

a)
b)
c)
d)
e)
f)

7. Por favor, liste os indivíduos ou grupos que são menos propensos a participar *(registar-se, classificar, comentar e/ou partilhar ideias, projetos, práticas ou recursos)* num espaço de afinidade de professores sobre a utilização de multimédia no ensino das ciências.

a)
b)
c)

d)
e)
f)

8. Forneça uma lista de todos os fatores ou circunstâncias que facilitem ou permitam a sua participação *(registar-se, classificar, comentar e/ou partilhar ideias, projetos, práticas ou recursos)* num espaço de afinidade de professores sobre a utilização de multimédia no ensino das ciências durante o próximo mês.

a)
b)
c)
d)
e)
f)

9. Forneça uma lista de todos os fatores ou circunstâncias que dificultem ou impeçam a sua participação *(registar-se, classificar, comentar e/ou partilhar ideias, projetos, práticas ou recursos)* num espaço de afinidade de professores sobre a utilização de multimédia no ensino das ciências durante o próximo mês.

a)
b)
c)
d)
e)
f)

FIM

Outras observações. Registe no verso desta folha quaisquer observações que considere importantes.

Por favor, verifique se respondeu a todas as questões. **Muito obrigado pela sua colaboração!**

Obrigado pela sua participação neste estudo.

Jorge Mota, Carla Morais e Luciano Moreira