BARRIERS IN COMPUTER-MEDIATED COMMUNICATION: TYPOLOGY AND EVOLUTION OVER TIME

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This study explores barriers in computer-mediated communication in a university collaborative learning community, specifically in a community of inquiry (CoI). We analyze the students' perceptions of the obstacles in their online communication, and the evolution of the obstacles over time. We use qualitative and quantitative analysis of the communication. Low levels of barriers are the most common, both in the communications and in the students' perceptions. There are statistically significant correlations between the different kinds of barriers, and the barriers decrease over time. We conclude that the technical barriers have particular concreteness. This research can be useful to minimize the possible implications of these obstacles for proper development of e-learning.

1 Introduction

For educational experiences to be effective, they should minimize aspects that can impose obstacles or block both learning and the student's satisfaction with his or her development. Public administrations, course designers, and professors should consider what barriers students encounter in their virtual education in order to maximize efforts and investments involved in making high-quality courses available to students.

The most recent reports indicate that students will learn in collaborative learning environments in years to come (Johnson *et al.*, 2013). The Community of Inquiry model indicates that high-level learning can develop in collaborative communities where interaction between individual meaning and socially constructed knowledge occurs (Garrison, Anderson & Archer, 2000).

Because certain high levels of obstacles in this type of community can paralyze communication and the learning process, it is worthwhile to analyze what barriers students may encounter in their virtual learning in collaborative learning environments.

We can tackle this topic through the following research questions:
• What barriers are observed in the communications?
• What barriers do the students perceive?
• Is there a correlation between these barriers?
• Are there differences in the barriers depending on the tool used?
• How do the barriers evolve during development of the teaching-learning process?

2 Theoretical background

While the use of technology in education has increased considerably in recent decades, educational research has also observed some factors that could influence the teaching-learning process negatively. Research began in the 1990s with studies by Berge (1998) and Berge & Mrozowski (1999), who focus investigation on the obstacles institutions could encounter in implementing online instruction, as well as barriers for professors (Betts, 1998; Salmon & Giles, 1999) and for students (Morgan & Tam, 1999).

In the following decades, this interest has not waned. Continued interested may be due to the substantial changes enabled by the advance in technology in the education system, changes produced by new tools and forms of communication among people involved in the process and which could enable overcoming some obstacles or the emergence of others (Berge, 2013). We can thus view the topic of barriers as a complex one that changes dynamically over time.

In higher education, research considers three objects of analysis: (a) bar-

riers of educational institutions in implementing and using technologies, (b) obstacles that professors encounter (in improving learning for their students, efficacy, and attitudes toward technology), and (c) impediments to students' achievement of the highest levels in their learning and satisfaction. One factor cuts across all parties involved in the process, the technical and technological one (Johnson *et al.*, 2011), that is, bandwidth, malfunctioning, and inadequate infrastructure.

In implementing online educational systems, institutions find barriers related to strategic planning, absence of institutional policies, and cost of implementation (Birch & Burnett, 2009), as well as technical knowledge, administrative structure, evaluation of efficacy, and organizational changes (among others, Nadelman, 2013). Professors (Lin, Huang & Chen, 2014; Sang *et al.*, 2010) may encounter both external and internal obstacles involving institutional support, preparation, time, personal motivation, and technical support. But obstacles such as resistance to change, not fulfilling expectations, professional development, culture, inconsistency between the technology and pedagogical beliefs, among others (Veletsianos, Kimmons & French, 2013), can also impede the process. Further, students may encounter obstacles in their communication and learning when using information and communication technologies. In-depth research is thus needed to overcome these obstacles and adapt the virtual teaching-learning process to the characteristics of each group and each person. Failure to analyze, understand, and overcome the barriers that students encounter in their online educational experiences may prevent universities from satisfying their teaching needs adequately in virtual environments.

There is currently an increase in the number of adults entering online higher education for a variety of reasons. These adults' social and personal characteristics (Lewis-Fitzgerald, 2005) can give rise to a series of attitudinal obstacles—physical, material, and structural (Hillage & Aston, 2001). But there are also mental barriers (related to their culture and prior knowledge), financial barriers, access barriers, learning design barriers (failure to adapt to their individual characteristics), and information barriers (insufficient or unattractive information (Longworth, 2003).

We can thus classify the barriers that students encounter in higher education into:
- Psychological barriers, understood as individual obstacles—anxiety, emotions, or motivation that can condition the communication process—or, as Hammond, Reynolds & Ingram (2011) indicate, a feeling of self-efficacy in using information and communication technologies (ICT).
- Sociological barriers are ideological, cultural, or religious ideas related to problems with communication between peers or with the instructor

(Koenig, 2010; Simuth & Sarmany-Schuller, 2012; Whelan, 2008) or to delay in feedback (Vonderwell, 2003). In some cases, social interaction is established as one of the critical barriers, along with administrative questions and the instructor, student motivation, and time and support for studies (Muilenburg & Berge, 2005).

- Technical or technological barriers can interrupt the communication process. The study by Simuth & Sarmany-Schuller (2012) finds, however, that students do not perceive technology as a barrier in their online courses.
- Cognitive issues may constitute another barrier in educational communication and can involve cognitive abilities and learning styles (Koenig, 2010), preparation to use technological tools (Salmon & Giles, 1999; Whelan, 2008), or the processes of coding and decoding messages (Berge & Mrozowski, 1999).

One current tendency in online community-based learning is that of the Community of Inquiry (CoI) model. This conceptual model explains the components of educational communities oriented to achieving learning objectives, and it considers the community as the place for performing a social activity in a constructive-cooperative framework for reconstruction of experience. The community is developed through collaboration (Garrison, Anderson & Archer, 2010) to achieve better learning results. The model is composed of three elements that are interrelated in virtual communications. Social presence is the participants' capability to project themselves to each other socially and emotionally as real people in order to promote direct communication between people, communication that represents the person (Akyol *et al.*, 2009). Cognitive presence indicates the point to which students are capable of constructing meaning through continuous reflection in a critical research community (Darabi *et al.*, 2011). Teaching presence is defined as the act of designing, facilitating, and orienting cognitive and social processes to obtain the cognitive and social results expected based onthe students' needs and capabilities (Kupczynski *et al.*, 2010).

Various studies have investigated barriers in this type of community. Lowenthal (2010) analyzes how digital storytelling can be a way to overcome social barriers to achieve a productive community. The study by Robinson (2013) finds difficulties in collaborative work in CoIs, including problems with the communications technology and lack of familiarity, motivation, or feeling, among others.

3 Methodology

The sample is composed of 98 university students (88.35% women and 11.65% men) in two academic years of study. The statistics on age were: *Min=19; Max=38; ẋ=22.74; σ=3.67*. The study uses a purposive sample (Cohen, Manion & Morrison, 2003). Over two academic years, we gathered information from a university elective in a b-learning environment that used virtual communication. The course that developed the communication was Information and Communication Technology in Education, a fourth-year university course in the Primary Education program in a Spanish university.

We held two classroom sessions, in which the professors explained the work method, learning goals, agenda, type of evaluation, etc. The students were then asked to perform an individual analysis of the study materials (forums, wikis, web pages, blogs, reports, ebooks, videos). They subsequently produced the communications—using an educational platform—based on the learning objectives. Reading of the work documents was sequenced and planned, and occurred prior to the chats and forums. The students and professors then carried out a collaborative project through virtual communication.

The groups of students constituted a learning community because, as Gairín (2006) indicates, they fulfill the following characteristics: the community places people at the center of the learning, the community permits all members access under equal conditions, the members perform a collaborative project, and the community facilitates participation and horizontal structures by which to function, and seeks effective models for functioning.

We developed a case study using a mixed methodology. We performed content analysis to analyze the typology of barriers in the virtual communication through forums, chats, and emails, and analyzed perception of the barriers through three questionnaires.

The chats were used as a place for discussion, collective reflection, and expression of personal opinions about study topics proposed by the professors, with individual preparation prior to the chat sessions (11 chat rooms). The forums served to continue debate that arose in the chats, contribute new information, and summarize the topics treated. The emails were devoted to specific clarifications from the students individually. The synchronous communications consisted of a total of 45 chats of 45 minutes each, over a period of seven weeks; and the asynchronous communications of 302 emails and 454 entries in the forums, which were open for participation for three months of each academic year.

We used the thematic unit as the unit of analysis and created a classification system in NVivo v.8 with the categories:
- technical barriers: technological situations that block or slow the virtual

communication, such as Internet connection or quality of transmission,
- sociological: factors that can impede fluid virtual communication due to ideological, cultural, or religious conceptions,
- psychological: individual impediments such as anxiety, emotions, motivation, interests, temperament, or rivalries that can condition the communication process,
- cognitive: impediments to virtual communication based on lack of knowledge or abilities from prior learning, whether academic or technical, related to preparation in using the virtual tools.

These categories are based on the proposals by Berge (1998), and Berge & Mrozowski (1999). Reliability of classification was achieved by ensuring that the classification system defined the categories correctly and that the different categories were assigned correctly through a double review.

We also administered questionnaires created *ad hoc* to analyze students' perception of barriers in order to contrast the data obtained. The data were evaluated by eight experts, who assessed the correctness of the items to be 85.7%. The Alpha Cronbach measures reliability: $\alpha=0.83$ (chat) $\alpha=0.77$ in the forum, and $\alpha=0.75$ (email). The responses were Likert-type, with a four-level ordinal scale (agree completely/disagree completely).

4 Results

4.1 Barriers encountered in the virtual communication

The obstacles encountered in the virtual communication represent 0.57% of the total communication in the chats, forums, and emails and occurred primarily with the chat tool (0.48%).

Figure 1 shows the thematic units classified as containing some kind of barrier, by percentages of the communication for each tool.
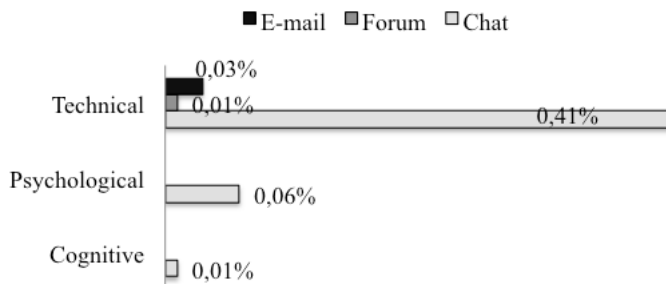

Fig. 1 - Percentage of the barriers of communication.

In the chats, we found a total of 101 thematic units related to obstacles in the virtual communication, distributed as indicated in Figure 1. For example, in the chats we found thematic units such as: "It's hard to follow the conversation, but I think it will be better next time" (*chat*) and "The page is not available, I've tried several times" (*chat*).

In the forum communications, we found thematic units referring to technical barriers. For example: "I'd like to put up my picture, but I tried lots of different ways and couldn't" (*forum*).

In the email communications, we found thematic units related to technical barriers. For example: "There was a problem with transferring the notes, but they are fixing it" (*email*).

4.2. Barriers perceived by the students

Next, Table 1 shows the items that refer to the barriers perceived by the students.

Table 1
DESCRIPTORS OF THE ITEMS ON BARRIERS IN THE COMMUNICATION

Barriers	Tool	Mean	S.D.
Psychological	Chat	1.52	.812
	Forum	1.45	.843
	Email	1.39	.726
Technical	Chat	2.18	1.029
	Forum	1.91	.997
	Email	2.14	1.037
Sociological	Chat	1.22	.545
	Forum	1.19	.474
	Email	1.22	.548
Cognitive	Chat	1.80	.851
	Forum	1.76	.803
	Email	1.70	.903

Among the three communication tools, the students perceived the most barriers when using, in decreasing order: technical barriers $\dot{x}=2.09; \sigma=,608$; cognitive barriers $\dot{x}=1.76; \sigma=,667$; psychological barriers $\dot{x}=1.21; \sigma=,388$; and sociological barriers.

Table 1 shows the data supporting the information in Figure 1. Most of the barriers in the category on communication are technical, and these are also the barriers most perceived by the members of the community. We analyzed the

correlations using the Pearson coefficient.

Table 2
CORRELATIONS BETWEEN THE BARRIERS

Correlations	Tools					
	Chat		Forum		Email	
	p	p-value	p	p-value	p	p-value
Psychological/ Technical	–	–	.278*	.029	.284*	.023
Psychological/ Socio-logical	.518**	.000	.681**	.000	.659**	.000
Psychological/ Cognitive	.538**	.000	.575**	.000	.494**	.000
Technical/ Sociological	.290*	.019	.311*	.014	.252*	.044
Technical/ Cognitive	–	–	.446**	.000	.503**	.000
Sociological/ Cognitive	.499**	.000	.470**	.000	.390**	.001

* Correlation is significant at 0.01 (2-tailed).
** Correlation is significant at 0.05 (2-tailed).

We see from Table 2 that there are correlations between nearly all of the barriers analyzed. The correlation of psychological barriers to social and cognitive ones is especially high. We observe no correlation, however, between technical and either cognitive or psychological barriers in the chat tool, and the correlations for technical barriers are generally lower in the other tools.

We also studied the correlations between the three tools to analyze whether the obstacles that people encounter in their virtual communication are seen in the same way in the different tools used. Table 3 presents the results.

Table 3
CORRELATIONS BETWEEN THE TOOLS

Barriers	Tools					
	Chat		Forum		Email	
	p	p-value	p	p-value	p	p-value
Psychological	.390**	.002	.549**	.000	–	–
Technical	.350**	.005	.570**	.000	.536**	.000
Sociological	–	–	–	–	.437**	.000
Cognitive	.253*	.048	.615**	.000	.392**	.001

* Correlation is significant at 0.01 (2-tailed).
** Correlation is significant at 0.05 (2-tailed).

4.3 Evolution of the barriers based on time

We crossed the information between the barriers found and the chat sessions to determine whether there was a relationship between the passage of time (and resulting mastery of the tool) and the barriers. We found the following:
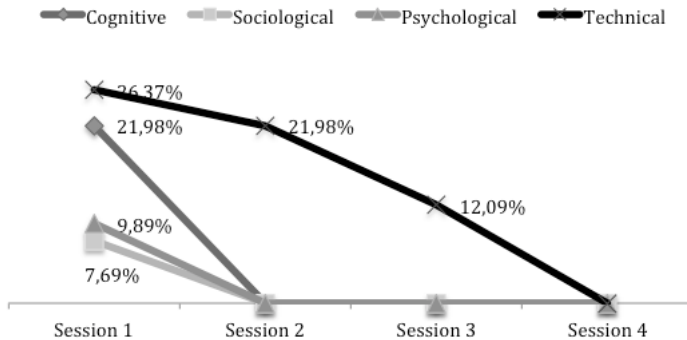

Fig. 2 - Evolution of barriers in the chats over time.

As can be seen in Figure 2, the barriers clearly decrease over time. The number of barriers thus decreases dramatically, declining gradually over the course of the sessions from the first moment, in which most of the barriers are concentrated (already a very low percentage), to the last, where no barriers are found.

Further, the percentage of appearance of barriers over time in the emails and forums is negligible.

Conclusions

This study analyzes the barriers found in a virtual learning environment in its synchronous and asynchronous modes. We explore the barriers observed in the online communication, the perception the students have of these barriers, and the evolution of the obstacles over time.

Minimizing the obstacles students encounter in their online communication is a priority for professors committed to the quality of virtual instruction in a collaborative learning community in higher education.

Our study finds very low levels of barriers in the communication, and the students' perception of these barriers was also very low. Technical barriers are the most frequent in the online communication, and the students perceive them most, a result that agrees with the argument by Johnson *et al.* (2011) that poor infrastructure or any technical impediment can hinder the teaching-learning

process. Psychological, cognitive, and sociological barriers are found to be minimal, however, and the students perceived fewer such barriers. This result leads us to think that students in higher education have acquired a series of competences that facilitate their communication in a virtual environment, such that there are no barriers internal to the students themselves—that is, psychological or cognitive—nor any related to their interaction with other members of the learning community. This result contrasts with the findings of Simuth & Sarmany-Schuller (2012).

The research cannot confirm impediments related to anxiety, motivation, or low feeling of self-efficacy, a result that agrees with the study by Hammond *et al.* (2011). Nor can it verify whether either ideological or attitudinal conceptions or cognitive abilities constitute barriers in virtual communication.

We did, however, observe higher correlations between the psychological, sociological, and cognitive barriers than between the technical barriers. These data lead us to think that the technical barriers, along with greater occurrence and perception, have a particular concreteness among the impediments to proper development of communication in a virtual teaching-learning environment.

If we observe the findings for the correlations between communication tools, we can conclude, again, that the technical barriers have the strongest correlation. These data may indicate that the students' perception of the chat, forum, or email is related to the tools.

The evolution of the barriers is seen through the chat communication tool, since in the other cases—the emails and forums—it is practically null. Through the content analysis of the virtual communications, we confirm that the psychological, sociological, cognitive, and technical barriers have a decreasing line of development. That is, we find greater incidence of these barriers at the beginning of the virtual communication, and they are gradually eliminated completely over the four weeks. This line of evolution differs, however, according to the type of barrier analyzed. Whereas the technical barriers continue over the four-week time period, the sociological, cognitive, and psychological ones are surmounted in the first week.

The current study has a series of limitations that should be taken into account in future research. It would be interesting to add more qualitative data in future studies. Increasing the number of students could enable generalization from the results, something not possible in this exploratory study. Future studies could also expand the field of knowledge by focusing on specific reasons for the technical problems found in order to facilitate overcoming them.

We believe that this study and possible future studies are useful for professors who develop their activity in e-learning, as well as for administrations and course designers, to enable them to minimize issues that have a negative influence on proper virtual communication.

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