International Journal of Technology and Human Interaction
Volume 18 • Issue 1

Communication Overload in Online Communities in Higher Education: A Case Study

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ABSTRACT

This paper presents part of a research project on the use of information technology by students and teachers to communicate with each other in online community contexts of higher education institutions. The part of this project which investigated whether the number of messages exchanged and the effort required to process them are a source of communication overload is the focus of the paper. The research was conducted at a Portuguese university, was supported by an analysis model, and data were collected through an online questionnaire. Descriptive statistics and inference tests were used to analyse a validated data sample of n = 570 students and n = 172 teachers. The results show that students and teachers generally perceive communication overload when using communication technologies to communicate with each other. This perception is particularly relevant when using email, and inference tests show that it is higher for teachers than for students.

KEYWORDS

Communication, Higher Education, Online Community, Overload, Technology

1 INTRODUCTION

Online communities have emerged from technology-based forums and are rooted in environments where individuals and organizations with common interests exchange information and knowledge (Autio, Esmt, & Frederiksen, 2013). As the Internet and mobile technology have become increasingly ubiquitous, the development and emergence of online communities has grown significantly and is now supported by a wide range of web products and services (Malinen, 2015).

The advantages of online communities are numerous in terms of collaborative work, knowledge transfer and information ubiquity (Fisher, 2019), but their success depends heavily on their members' participation (Faraj, Jarvenpaa & Majchrzak, 2011). This raises several challenges, including strategies to keep the participants motivated in the community (Malinen, 2015). The information and communication overload may be an issue in online communities (Pirkkalainen & Salo, 2016; Zhang, 2018) and may jeopardize their sustainable interaction (Ouardi *et al*., 2016; Ramadan & Abosag, 2017).

DOI: 10.4018/IJTHI.293194 *Corresponding Author

Currently, higher education institutions may be seen as online communities (Kent, Rechavi, & Rafaeli, 2019; Witzig, Spencer, & Myers, 2017) because of the digital transformation they are facing (Santos, Batista, & Marques, 2019b). Thus, information and communication overload can also be seen in this context. For example, students often feel more overloaded in courses that use e-learning environments compared to traditional classroom courses that do not use such online communities (Kushnir, 2009). In the same vein, Chen, Pedersen and Murphy (2011) describe that students are more overloaded in virtual learning environment courses than in traditional classroom courses. In online education, overload is a significant factor in interactions between teachers and students.

However, information and communication overload is not an issue that has been researched substantially with regard to its effects or strategies for dealing with the information produced and shared through participation in this type of online community (Kearns, Frey, Tomer, & Alman, 2014).

This paper presents part of the results of a more comprehensive research project that analysed how students and teachers from higher education institutions use communication technologies (CT) to communicate (Santos, Batista, & Marques, 2019a, 2019b). On this paper, the results on the perception of the communication overload that students and teachers perceive through CT are described and discussed, subject to the following:

- Research question: do students and teachers perceive communication overload when they use CT to communicate with each other?

Figure 1 presents the research model, indicating the main stages of the research and the approach followed. A literature review was carried out (section 2) and the methodology to be applied was defined (section 3). Following the methodology, data were collected, and the results were produced (section 4) which were the subject of analysis and discussion, supporting the answer to the research question (section 5). Finally, the conclusions of this investigation and some future research directions are described in section 6.

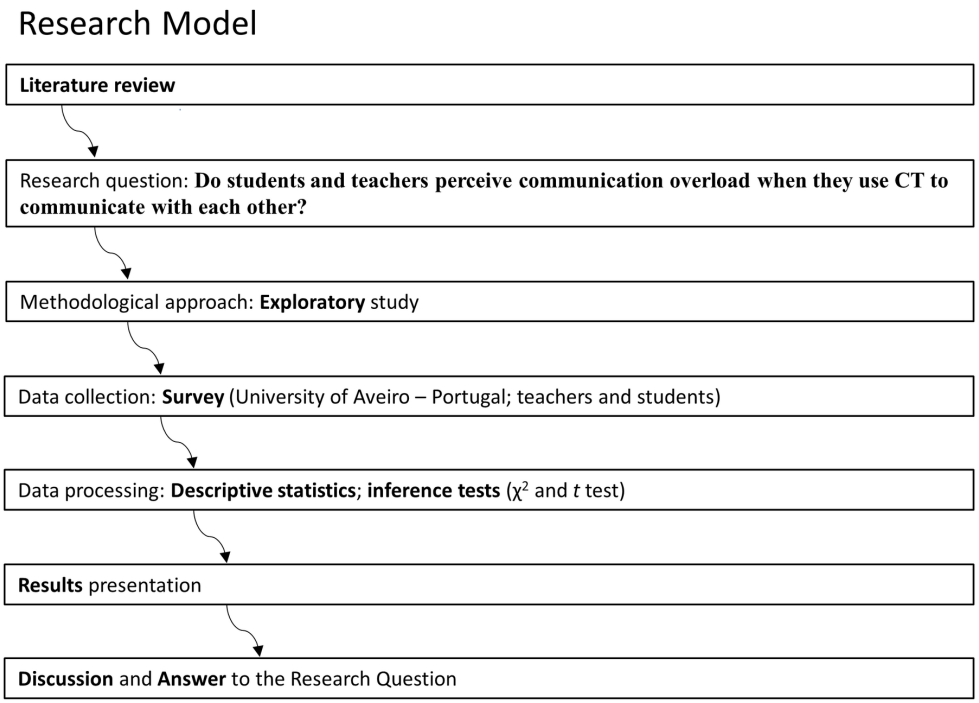
2 LITERATURE REVIEW

The concept of Communication Overload is often associated with the concept of Information Overload, being practically inseparable since the communication process presupposes the transmission of information. A bibliometric analysis has shown that information overload and communication overload problems are nowadays interrelated (Batista & Marques, 2017).

In addition, opportunities in the digital age have created solutions to some information overload problems, but at the same time, they have created new challenges. Many of these challenges arose with the development of CT that allowed the dissemination and exchange of large amounts of information, now so intense and so present in the lives of individuals, organizations, and societies, that they represent a new problem: communication overload (Batista & Marques, 2017).

There are several definitions of these concepts. One of the most used and cited definition of Information Overload is known by an inverted u-curve, which establishes a cause-effect relationship between the amount of information available and the ability of individuals to make decisions (Eppler & Mengis, 2004). Thus, the more information available, the greater the decision-making capacity will be until this trend is reversed. This occurs when the amount of information is excessive, making it difficult to process efficiently and therefore contributing negatively to decision making. At this point, information overload occurs (Eppler, 2015; Eppler & Mengis, 2004). This approach corroborates previous definitions, namely by Meyer (1998) and Jacoby (1984), who state that information overload can occur when the volume of information exceeds the limit of human processing capacity and, as a result of this overload, dysfunctional effects such as stress and confusion can occur. In addition,

Figure 1. The research model followed during this research



overload is a phenomenon that can also be perceived when the information and / or communication exceeds people's ability to process it within a certain period (Marques & Batista, 2017).

The communication overload phenomenon occurs when individuals, organizations or societies are unable to handle and process all communication processes in which they are involved. If preventive approaches are taken, problems associated to information and communication overload can have less impact and can be mitigated. Individuals and organizations can eventually plan and design their data access processes and select the most appropriate communication channels for their needs, avoiding situations of information and communication overload (Batista & Marques, 2017; Jackson & Farzaneh, 2012).

Communication Overload in Online Communities in Education

In carrying out this literature review, several studies were found in the context of the use of CT, mainly in relation to the use of electronic mail (email). Email has become almost universal and higher education institutions use it as an institutional communication channel par excellence. Thus, most of the studies listed here deal with information and communication overload in email in the higher education context.

A study at Australian universities looked at the perceived overload of academic and non-academic professionals at their institutions and found that, although the volume of email was higher in the faculty, they used less email management strategies. The study found that increased email exchange is associated with communication overload, resulting in increased work-related stress. The authors suggest that email overload characterizes the work environment of the academic and professional staff at contemporary universities (Pignata, Lushington, Sloan, & Buchanan, 2015).

Kushnir (2009) studied factors that can contribute to the perception of overload by students. The findings state that overly busy online environments that contain irrelevant information had a negative impact on learning for students ranked "high" on their experience with e-learning technologies, but no impact on other students' learning. The author concludes that online environments contain large amounts of information and stimuli, often some of which are irrelevant and distracting. The way you deal with irrelevant or distracting information and stimuli can have a significant impact on learning. Surprisingly, the author suggests that overload affected only experienced students.

Other studies on email overload reported that email is a very beneficial means of communication, but has a disadvantage, which is the information and communication overload. One of the reasons for this overload is that current email clients do not provide an inbox structure that facilitates email prioritization, information structuring and workflow management (Szóstek, 2011). Soucek and Moser (2010) also found out three reasons for information and communication overload in the use of email: large amount of information received, inefficient workflow and poor communication quality. Jackson and Farzaneh (2012) concluded that information and communication overload can lead to reduced productivity and performance, learning and innovation difficulties and, consequently, affect decision making, well-being and high costs for organizations.

A study on information and communication overload on users of the Twitter social network observed the following variables: number of friends; the overload of perceived information; and tweet processing methods. The results indicated that users who perceive overload do not select a strategy to decrease the tweets received, but rather change the method of processing tweets received (Sasaki, Kawai, & Kitamura, 2015; Sasaki, 2016).

Most of the studies on the use of email in higher education contexts report overload, as it is a reality for which no solution has yet been completely found. The issue of overload is something that bothers the online academic community, as there is excessive information, often unnecessary, that often requires efficient managing and filtering mechanisms to reach relevant information. In this sense, higher education institutions must create easy and simple solutions and mechanisms to help reduce the existing overload. It is believed that due to overload, a student is more likely to look for a social network, which has a less formal and faster access (Straumsheim, 2016).

Rubio and Villalon (2016) state that online learning communities face two major problems for its development, the low quality and quantity of participation and information overload, due to the large amount of participation and that can be solved by giving instant feedback and sorting the data available in the online environment.

Open innovation communities are growing in many sectors because they offer opportunities for collaboration and help organizations to innovate. However information overload is a problem, due to the characteristic of the community (Lee *et al*., 2018). These authors propose a solution to mitigate the information overload in an open innovation environment. Another study (Zhang, 2018) investigated information and communication overload in large online courses and also suggests a solution to combat overload by developing an Agent-Based Model (ABM) of student interaction in a collaborative computer supported learning environment.

3 METHODOLOGY

To answer the general research question for the entire project and to answer the specific question stated in the introduction, an analysis model was developed, previously described in other documents (Santos, Batista, & Marques, 2019a, 2019b). Communication technology is one of the concepts that structure this model of analysis, and the users' perception of overload when using CT is one of the dimensions addressed in this concept.

In this dimension, two indicators were considered, both reflecting the fact that the human processing capacity is limited. The first indicator is about the occurrence of a perception of overload when the user is faced with a lot of information and / or communication within a certain period,

having to overcome their processing limits. In this sense, it is necessary to understand overload as excess information and / or communication, so that the user is not able to process it fully or correctly (Bettman, Luce & Payne, 1998). This can cause confusion, rather than helping people in decision-making processes (Lee & Lee, 2004). The second indicator concerns the effort required to process the information / communication considered useful, controlling the irrelevant and competing information / communication (Pinto, 2001).

Thus, this paper aims to analyze the number of messages exchanged and the effort required to process the information conveyed in these messages, which are the two indicators mentioned above. To check if the number of messages exchanged causes a perception of communication overload in users, which is the first indicator, the following question was presented to students and teachers:

Question 1: How often do you perceive communication overload considering the number of messages exchanged using the following options?

To verify whether the effort to process communication causes a perception of communication overload in users, which is the second indicator, the following question was presented to students and teachers:

Question 2: How often do you perceive communication overload considering the effort required to process communication using the following options?

To ask these two questions, a CT taxonomy was adopted, resulting from the adaptation of previous classifications (Batista, Morais, & Ramos, 2016; Silva, Ramos, & Batista, 2016). The taxonomy is presented in Table 1 and includes the following categories: applications for publishing and sharing content; applications that allow collaboration; applications that enable interpersonal communication; and social networks. In the case of interpersonal CT, some subcategories were also considered, namely Email, Instant messaging, and Videoconferencing and voice systems.

Questions 1 and 2 were asked to the participants (students and teachers) in relation to each of the CTs in the Table 1 taxonomy. For this, a Likert scale was used with the following items: never, rarely, sometimes, many times, and always.

Table 1. Communication technologies taxonomy

Categories	Sub-categories	Examples
Publishing and sharing technologies		Youtube, Moodle, Flickr, Blogs, etc.
Collaborative technologies		Google Drive, Slack, Wiki, etc.
Interpersonal communication technologies	Email	Gmail, Hotmail, etc.
	Instant messaging	Messenger, WhatsApp, SMS, etc.
	Videoconferencing and voice systems	Skype, Google Hangouts, etc.
Social networks		Facebook, Twitter, Linkedin, etc.

To find answers to these two questions and to the questions resulting from the other concepts and dimensions of the analysis model, an online survey was conducted to apply an original questionnaire. This questionnaire was applied online and validated through pre-tests. The questionnaire was applied to students and teachers at the University of Aveiro between March 22 and May 9, 2018.

The two data samples, one from students and the other from teachers, were processed using descriptive statistics techniques. Also, inference tests were used to test the independence of the two data samples (χ^2 and t test) and to verify whether the differences between the two data samples are statistically significant. The test results were considered significant when the test value was equal to or less than a significance level of $\alpha = 0.05$ (p £ 0.05). The results are strengthened if the results of the two tests are found to be consistent. It would be enough to carry out only one of these independence tests, the non-parametric χ^2 test or the parametric t test, but the authors considered it useful to carry out both tests and verify whether the results were consistent between them.

4 RESULTS

This section presents the results. First, sample data from students and teachers' responses are described and characterized, followed by the responses students and teachers gave to the two questions described in the previous section, namely about their perceptions of communication overload in relation to their use of CT to communicate with each other.

Data

The student population consists of 14,703 students from the University of Aveiro (Portugal), having been validated $n = 570$ complete answers to the questionnaire (3.9% of the student population). The analysis of their answers shows that more women (78.8%) than men answered (21.2%); most students are under 20 years old (23.9%) or between 20 and 24 years old (44.4%); most students attended bachelor's or master's degree (86.5%); the most represented scientific program areas were health sciences (11.6%) and mathematical sciences (9.9%); and the most represented departments were those of biological sciences (14.7%) and health sciences (12.8%), however all the scientific areas are represented in the data sample.

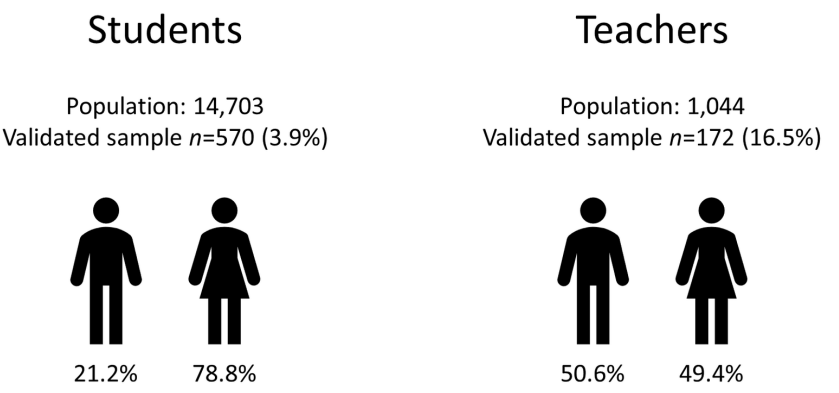
In the case of teachers, the population consists of 1,044 teachers from the University of Aveiro, having been validated $n = 172$ complete answers to the questionnaire (16.5% of the population). The analysis of their answers shows that responded slightly more men (50.6%) than women (49.4%); the 45-49 age group is the most represented (20.9%); most teachers are between 35 and 59 years old (77.8%); and the most represented scientific areas are health sciences (11.6%) and mathematics (9.9%), however all the scientific areas are represented in the data sample. Figure 2 briefly illustrates the data sample of this study.

Communication Overload Perception: Question 1

Students and teachers were asked about their perception of communication overload when using CT. Table 2 shows the relative frequencies of responses from students and teachers to the question 1: "How often do you perceive communication overload considering the number of messages exchanged using the following options?". The following scale was used to answer this question: never (1); rarely (2); sometimes (3); many times (4); always (5).

Some aspects result from the analysis of Table 2. First, the perception of communication overload considering the number of messages exchanged is generally higher by teachers than by students. This is true in all the CT categories when the answers of "sometimes", "many times" and "always" are aggregated. However, if we sum just the categories "many times" and "always", it happens that students show to feel a higher overload perception than teachers when collaborative technologies are used: 19.1% of students and 12.2% of teachers answered "many times" or "always". This is the only case that shows that students feel more overload than teachers in terms of the number of messages

Figure 2. Sample data from students and teachers



exchanged. Thus, it may be said that, in general, teachers show to feel more overload than students when CT are used, considering the number of messages exchanged.

Second, if the answers of "never" and "rarely" are aggregated, there are higher values on the part of students than teachers in all categories of CT considered. In some cases, this low perception of communication overload is manifested by more than 50% of students, namely in the use of videoconferencing and voice systems (70.8%) and social networks (51.6%). In the case of teachers, the CT that they claim are less causing communication overload are publishing and sharing technologies (33.8%) and videoconferencing and voice systems (44.7%). Thus, the videoconferencing and voice systems are the CT that students and teachers say they feel that cause lower levels of overload communication, considering the number of messages exchanged.

Finally, two CT categories emerge as the most evident causes of overload communication, considering the number of messages exchanged, namely the email and the instant messaging technologies, both under the interpersonal communication category. In fact, aggregating the answers of "sometimes", "many times" and "always" we can see that 62.7% of students and 77.8% of teachers feel communication overload using email, and that 55.0% of students and 72.0% of teachers feel the same way using instant messaging technologies. In the specific case of email, 12.7% of teachers and 3.6% of students answer that they feel "always" overload by the number of messages exchanged.

Inference tests were applied to check whether the answers to question 1 are independent whether they are from students or from teachers. The results of these tests are shown on Table 3.

Some results emerge from the analysis of the results shown in Table 3. First, the test results are not statistically significant for publishing and sharing technologies, collaborative technologies, and social networks, which means that being a student or a teacher does not influence the results. Second, in the case of email and videoconferencing and voice systems categories, the results are statistically significant, meaning that the perception of communication overload that students and teachers have, is different in those CT categories. Third, the results are mixed in the case of instant messaging category, being significant in the t test and not in the case of the χ^2 test, giving mixed results. Finally, except for the instant messaging category, the results of the two tests for each category of CT are consistent with each other. That is, with the exception of the referred category, in all the other categories it happens to be both statistically significant or both not to be statistically significant.

Table 2. Relative frequency in relation to communication overload, considering the number of messages exchanged (Question 1)

	Students / Teachers	Never (1)	Rarely (2)	Sometimes (3)	Many times (4)	Always (5)
Publishing and sharing technologies	Students	23.0%	26.3%	36.4%	12.4%	1.8%
	Teachers	16.0%	28.8%	33.6%	21.6%	0.0%
Collaborative technologies	Students	24.8%	23.8%	32.4%	18.1%	1.0%
	Teachers	9.8%	31.7%	46.3%	12.2%	0.0%
Interpersonal communication technologies: email	Students	16.0%	21.3%	37.1%	22.0%	3.6%
	Teachers	8.4%	13.9%	21.7%	43.4%	12.7%
Interpersonal communication technologies: instant messaging	Students	21.2%	23.2%	36.4%	19.2%	0.0%
	Teachers	10.0%	18.0%	42.0%	28.0%	2.0%
Interpersonal communication technologies: videoconferencing and voice systems	Students	38.9%	31.9%	19.4%	9.7%	0.0%
	Teachers	17.9%	26.8%	37.5%	14.3%	3.6%
Social networks	Students	21.3%	30.3%	25.8%	18.0%	4.5%
	Teachers	18.2%	13.6%	31.8%	31.8%	4.5%

Table 3. Statistical inference test results to verify the independence of student and teacher responses to question 1 (p £ 0.05)

Perception of communication overload – number of messages exchanged	χ^2 *p-value*	*t* *p-value*
Publishing and sharing technologies	0.221	0.139
Collaborative technologies	0.258	0.396
Interpersonal communication technologies: email	0.000	0.000
Interpersonal communication technologies: instant messaging	0.117	0.023
Interpersonal communication technologies: videoconferencing and voice systems	0.011	0.002
Social networks	0.080	0.086

Communication Overload Perception: Question 2

The second question that students and teachers were asked to answer is the following: "How often do you perceive communication overload considering the effort required to process communication using the following options?". The scale used to answer this question is identical to that used to answer Question 1, which is: never (1); rarely (2); sometimes (3); many times (4); always (5).

The relative frequencies of student and teacher responses to this question are shown in Table 4. Some aspects result from the analysis of Table 4. First, the perception of communication overload is higher by teachers than by students in all categories of CT. This is true when the answers of "sometimes", "many times" and "always" are aggregated, as well when just the answers of "many times" and "always" are aggregated, giving evidence of a more frequent perception of overload communication by teachers than by students in every category of CT considered.

Second, when responses of "never" and "rarely" are aggregated, the low perception of communication overload is more frequently perceived by students than by teachers in all the categories of CT considered. This low frequently perception is especially evident in the case of students use of videoconferencing and voice systems (63.9%). In the case of teachers, also aggregating "never" and "rarely" responses, the frequency ranges between 30.0% in the case of instant messaging, and 41.1% in the case of videoconferencing and voice systems. Out of this range is found that just 18.7% of them perceive "never" or "rarely" communication overload using email.

Finally, the email emerges as the category of CT that students and teachers more frequently perceive communication overload considering the effort required to process communication. When aggregating together the responses of "sometimes", "many times" and "always", 62.6% of students and 81.4% of teachers also perceive that way. Under similar aggregating conditions, instant messaging is the second most mentioned CT category (56.5% of students and 70.0% of teachers). In the specific

Table 4. Relative frequency in relation to communication overload, considering the effort required to process communication (Question 2)

	Students / Teachers	Never (1)	Rarely (2)	Sometimes (3)	Many times (4)	Always (5)
Publishing and sharing technologies	Students	23.0%	22.6%	43.8%	8.8%	1.8%
	Teachers	12.0%	23.2%	43.2%	21.6%	0.0%
Collaborative technologies	Students	26.7%	22.9%	29.5%	20.0%	1.0%
	Teachers	7.3%	24.4%	43.9%	24.4%	0.0%
Interpersonal communication technologies: email	Students	15.5%	22.0%	41.3%	18.9%	2.4%
	Teachers	6.0%	12.7%	26.5%	41.6%	13.3%
Interpersonal communication technologies: instant messaging	Students	20.2%	23.2%	42.4%	14.1%	0.0%
	Teachers	8.0%	22.0%	40.0%	26.0%	4.0%
Interpersonal communication technologies: videoconferencing and voice systems	Students	36.1%	27.8%	26.4%	9.7%	0.0%
	Teachers	10.7%	30.4%	37.5%	14.3%	7.1%
Social networks	Students	22.5%	25.8%	36.0%	14.6%	1.1%
	Teachers	15.9%	20.5%	31.8%	27.3%	4.5%

case of email, 13.3% of teachers and 2.4% of students answer that they feel "always" overload by the effort required to process communication.

Inference tests were applied to verify that the answers given to question 2 are independent of whether they are given by students or given by teachers. The results of these tests are shown in Table 5. The analysis of this table results in the following observations. First, test results are not statistically significant for social networks, which means that being a student or teacher does not influence the response. Second, regarding publishing and sharing technologies, email and videoconferencing and voice systems, the results are statistically significant, meaning that the perception of communication overload that students and teachers perceive is different, considering the effort required to process communication. Third, the results are mixed in the case of collaborative technologies and instant messaging category, being significant in the *t* test and not in the case of the χ^2 test, giving mixed results. being significant in the *t* test and not in the case of the χ^2 test, giving mixed results. Finally, except for collaborative technologies and instant messaging categories, the results of the two tests for each CT category are consistent with each other, both being statistically significant or both not statistically significant.

Table 5. Statistical inference test results to verify the independence of student and teacher responses to question 2 (p £ 0.05)

Perception of communication overload – effort required to process information	χ^2 *p-value*	*t* *p-value*
Publishing and sharing technologies	0.013	0.005
Collaborative technologies	0.130	0.026
Interpersonal communication technologies: email	0.000	0.000
Interpersonal communication technologies: instant messaging	0.053	0.008
Interpersonal communication technologies: videoconferencing and voice systems	0.027	0.000
Social networks	0.095	0.056

5 DISCUSSION AND ANSWER TO THE RESEARCH QUESTION

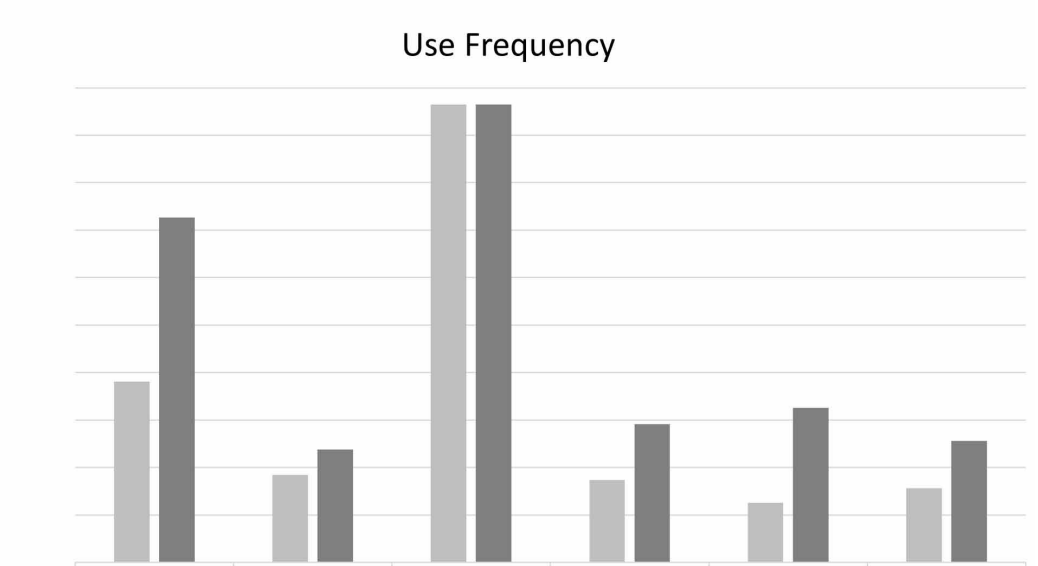
Considering the results just described, we can now proceed to answer the research question:

- Do students and teachers perceive communication overload when using CT to communicate with each other?

To answer this question, we add the results that were obtained, through the same questionnaire, on the frequency with which students and teachers use each of the CTs already mentioned (Figure 3). The data in this table shows that the use of email is very high for both students and teachers, being also very high the use of publishing and sharing technologies. In a systematic way, teachers use CT more than students to communicate with each other, apart from email, in which both teachers and students show an especially high and similar utilization rate (96.5%).

Combining the results of the use frequency (Figure 3) with the results presented in the previous section, some points can be highlighted. First, there is a general trend of greater perception of communication overload on the part of teachers than on the part of students. This result is consistent in both questions posed to students and teachers, considering the number of messages exchanged and the effort to process communication. A possible explanation is the fact that in general each teacher

Figure 3. Use frequency of communication technologies by students and teachers to communicate each other. (ICT: interpersonal communication technologies).



	Publishing and sharing technologies	Collaborative technologies	ICT: email	ICT: instant messaging	ICT: videoconf. and voice systems	Social networks
Students	38.10%	18.40%	96.50%	17.40%	12.60%	15.60%
Teachers	72.70%	23.80%	96.50%	29.10%	32.60%	25.60%

communicates with many students and, conversely, each student usually communicates with a small number of teachers. This explanation appears to be plausible for the higher perception that teachers have of communication overload.

Second, the results point to higher levels of perception of communication overload in relation to the use of email than in relation to other categories of CT. These results are quite similar in both questions, reaching higher levels in teachers than students, which may be explained by the fact that, in general, each student communicates with a small number of teachers, but on the contrary, each teacher communicates with many students. Although students and teachers use email for other tasks, it is recognized that higher education teachers are often involved in various tasks that make intensive use of email, such as institutional management tasks and research tasks, which can help to explain a high perception of communication overload.

Third, still regarding email, inference tests confirm that teachers perceive more communication overload than students, in relation to the number of messages exchanged and in relation to the effort required to process the communication.

Fourth, there are also statistically significant differences in the perception of communication overload in relation to the use of publishing and sharing technologies, however this is evident just in the question of the effort required to process communication. In this case, the communication overload perception is higher in teachers than in students. It also adds that this is a widely used CT, more by teachers than by students. In fact, teachers have a responsibility to produce, prepare, and share educational materials to students, usually through publishing and sharing technologies. Most students just access and consume these materials, so it is not surprising that teachers perceive, more than students, communication overload with the use of publishing and sharing technologies.

Fifth, statistical data and inference tests showed, for both question 1 and question 2, that the perception of communication overload when using instant messaging systems is higher for teachers

than for students. In question 2, the χ^2 test did not confirm the result of the *t* test. However, the fact that the *p*-value is almost significant ($p = 0.053$), considering the size of the data samples, and the fact that the *t* test is a parametric test, allow us to consider the validity of this result. Thus, it can be considered that, for both questions, teachers have a higher perception of communication overload than students when using instant messaging systems, which is consistent with the fact that in general each teacher communicates with many students and, conversely, each student usually communicates with a small number of teachers.

Finally, the use of videoconferencing and voice systems also shows significantly higher levels of communication overload to teachers than to students, both in terms of the number of messages and of the effort required to process communication. However, at least at the time the data were collected, this was not a CT with high levels of use, especially by students. It would be interesting to have new data from the period after de COVID-19 pandemic has started, because of the more frequent use of CT tools of this type, such as Zoom or Microsoft Teams, for instance.

Answering to the research question "do students and teachers perceive communication overload when using CT to communicate to each other, both in terms of the number of messages exchanged and of the effort required to process communication?", we observe that: a) the perception of overload is real, both in terms of the number of messages exchanged and in terms of the effort required to process communication; b) the perception of communication overload is generally higher to teachers than to students, which is, in some cases, confirmed by results of statistical inference tests; and c) email emerges as the most problematic CT in terms of communication overload, which is reinforced by the fact that it is a CT largely used by both students and teachers.

This discovery is in line with the related works mentioned in section 2, confirming that in higher education institutions email is a source of communication overload. The fact that our results add that, at least in this case, these concerns are specifically due both to the number of messages exchanged and to the effort to process communication, seems to be a significant result and adds to the previous published work, reinforcing the need to adopt solutions to mitigate the mentioned issues of low productivity, performance and learning outcomes.

To conclude this section, a brief note on the use of two inference tests. As mentioned, the χ^2 and *t* tests were performed to verify that the results of the two tests were consistent with each other. In fact, they were generally consistent, with only minor inconsistencies in the cases of use of instant messaging services (question 1 and question 2) and in the use of videoconferencing and voice systems (question 2). In all other technologies, the two tests showed results in the same direction, which indicates that the results of the statistical process are reliable.

6 CONCLUSION AND FUTURE RESEARCH

The results of this study show that the number of messages exchanged, as well as the effort required to process communication when students and teachers communicate, are a source of problems related to communication overload. This happens with the use of several CT's, but mainly regarding the use of email.

Although the use of email is widely recognized as a source of communication overload, adequate measures have not been taken to mitigate this problem, at least in online communities, such as higher education institutions. This is identified in the literature review and confirmed by the results described in this paper.

With the pandemic reality of COVID-19, the use of CT has changed in higher education institutions, in which many activities have been carried out remotely using CT, the use of videoconferencing and voice systems being a clear example. Thus, it would be interesting to compare the results described in this paper with new data collected soon. In particular, the possibility of collecting these new data at the same university and at a similar time of year offers the opportunity to carry out a comparative study that shows how, at least in this case, the use of CT has changed with this new reality.

An important limitation of this study is the fact that it only collected exploratory data in which a symptom is identified, namely the perception of communication overload. This study does not address the causes of this perception, nor does it identify or propose specific solutions to deal with it. However, it presents results that give some empirical evidence that the use of communication technologies may effectively be a source of communication overload. These results show that the communication overload is felt more intensely by teachers than by students, and that email is the main technology whose use causes this symptom. The practical and managerial implication is that it is necessary to better identify the causes of this problem so that the use of communication technologies in online communities in higher education is more a solution than a problem for communication between students and teachers, reducing or minimizing the constraints resulting from its use.

As future research, we believe it will be useful to extend this study to other comparable higher education institutions to adjust and improve the research model and produce more general results that can, therefore, support the decision-making of higher education institutions on the issues identified.

REFERENCES

Autio, E., Esmt, L. D., & Frederiksen, L. (2013). Information exposure, opportunity evaluation, and entrepreneurial action: An investigation of an online user community. *Academy of Management Journal*, *56*(5), 1348–1371. doi:10.5465/amj.2010.0328

Batista, J., & Marques, R. P. (2017). An overview on information and communication overload. In R. P. Marques & J. Batista (Eds.), *Information and Communication Overload in the Digital Age* (pp. 1–19). IGI Global. doi:10.4018/978-1-5225-2061-0.ch001

Batista, J., Morais, S., & Ramos, F. (2016). Researching the use of communication technologies in higher education institutions in Portugal. In M. Pinheiro & D. Simões (Eds.), *Handbook of research on engaging digital natives in higher education settings* (pp. 280–303). IGI Global. doi:10.4018/978-1-5225-0039-1.ch013

Bettman, J., Luce, M., & Payne, J. (1998). Constructive consumer choice processes. *The Journal of Consumer Research*, *25*(3), 187–217. doi:10.1086/209535

Chen, C.-Y., Pedersen, S., & Murphy, K. L. (2011). Learners' perceived information overload in online learning via computer-mediated communication. *Research in Learning Technology*, *19*(2), 101–116. doi:10.3402/rlt.v19i2.10345

Eppler, M. J. (2015). Information quality and information overload: The promises and perils of the information age. In L. Cantoni & J. A. Danowski (Eds.), *Communication and Technology* (pp. 215–232). De Gruyter Mouton. doi:10.1515/9783110271355-013

Eppler, M. J., & Mengis, J. (2004). The concept of information overload: A review of literature from organization science, accounting, marketing, MIS, and Related Disciplines. *The Information Society*, *20*(5), 325–344. doi:10.1080/01972240490507974

Faraj, S., Jarvenpaa, S., & Majchrzak, A. (2011). Knowledge collaboration in online communities. *Organization Science*, *22*(5), 1121–1367. doi:10.1287/orsc.1100.0614

Fisher, G. (2019). Online communities and firm advantages. *Academy of Management Review*, *44*(2), 279–298. doi:10.5465/amr.2015.0290

Jackson, T. W., & Farzaneh, P. (2012). Theory-based model of factors affecting information overload. *International Journal of Information Management*, *32*(6), 523–532. doi:10.1016/j.ijinfomgt.2012.04.006

Jacoby, J. (1984). Perspectives on information overload. *The Journal of Consumer Research*, *10*(4), 432–435. doi:10.1086/208981

Kearns, L. R., Frey, B. A., Tomer, C., & Alman, S. (2014). A study of personal information management strategies for online faculty. *Journal of Asynchronous Learning Networks*, *18*(1). Advance online publication. doi:10.24059/olj.v18i1.296

Kent, C., Rechavi, A., & Rafaeli, S. (2019). The relationship between offline social capital and online learning interactions. *International Journal of Communication*, *13*, 1186–1211.

Kushnir, L. P. (2009). When knowing more means knowing less: Understanding the impact of computer experience on e-learning and e-learning outcomes. *The Electronic Journal of E-Learning*, *7*(3), 289–300.

Lee, B.-K., & Lee, W.-N. (2004). The effect of information overload on consumer choice quality in an online environment. *Psychology and Marketing*, *21*(3), 159–183. doi:10.1002/mar.20000

Lee, H., Choi, K., Yoo, D., Suh, Y., Lee, S., & He, G. (2018). Recommending valuable ideas in an open innovation community: A text mining approach to information overload problem. *Industrial Management & Data Systems*, *118*(4), 683–699. doi:10.1108/IMDS-02-2017-0044

Malinen, S. (2015). Understanding user participation in online communities: A systematic literature review of empirical studies. *Computers in Human Behavior*, *46*, 228–238. doi:10.1016/j.chb.2015.01.004

Marques, R. P., & Batista, J. (2017). *Information and communication overload in the digital age*. IGI Global. doi:10.4018/978-1-5225-2061-0

Meyer, J. A. (1998). Information overload in marketing management. *Marketing Intelligence & Planning*, *16*(3), 200–209. doi:10.1108/02634509810217318

Ouardi, Y., Goyal, T., Graf-Vlachy, L., Mammen, J., König, A., & Saunders, C. (2016). The cost of sharing: The effect of sharing inclination on information overload. *Proceedings of 24th European Conference on Information Systems*.

Pignata, S., Lushington, K., Sloan, J., & Buchanan, F. (2015). Employees' perceptions of email communication, volume and management strategies in an Australian university. *Journal of Higher Education Policy and Management*, *37*(2), 159–171. doi:10.1080/1360080X.2015.1019121

Pinto, A. C. (2001). Memória, cognição e educação: implicações mútuas. In B. Detry & F. Simas (Eds.), *Educação, cognição e desenvolvimento: Textos de psicologia educacional para a formação de professores* (pp. 17–54). Edinova.

Pirkkalainen, H., & Salo, M. (2016). Two decades of the dark side in the information systems basket: Suggesting five areas for future research. *Proceedings of the 24th European Conference on Information Systems*.

Ramadan, Z. B., & Abosag, I. (2017). The mystique of customers' saturation in online brand communities. In S. Sabah (Ed.), Consumer Behavior: Practice Oriented Perspectives (pp. 9–27). IntechOpen.

Rubio, D., & Villalon, J. (2016). A latent semantic analysis method to measure participation quality online forums. In *Proceedings of the 16th International Conference on Advanced Learning Technologies*, (pp. 18–19). Institute of Electrical and Electronics Engineers. doi:10.1109/ICALT.2016.5

Santos, H., Batista, J., & Marques, R. P. (2019a). A Model to Evaluate the Use of Communication Technologies in the Communication between Students and Teachers in Higher Education. In *Proceedings of EDULEARN - 11th International Conference on Education and New Learning Technologies* (pp. 4209-4216). Palma, Spain: IATED. doi:10.21125/edulearn.2019.1066

Santos, H., Batista, J., & Marques, R. P. (2019b). Digital transformation in higher education: The use of communication technologies by students. *Procedia Computer Science, 164*, 123–130.

Sasaki, Y., Kawai, D., & Kitamura, S. (2015). The anatomy of tweet overload: How number of tweets received, number of friends, and egocentric network density affect perceived information overload. *Telematics and Informatics*, *32*(4), 853–861. doi:10.1016/j.tele.2015.04.008

Sasaki, Y., Kawai, D., & Kitamura, S. (2016). Unfriend or ignore tweets: A time series analysis on Japanese Twitter users suffering from information overload. *Computers in Human Behavior*, *64*, 914–922. doi:10.1016/j.chb.2016.07.059

Silva, E., Ramos, F., & Batista, J. (2016). Desafios no desenvolvimento de competências comunicacionais nos cursos de licenciatura das universidades do nordeste brasileiro. *Ciência da Informação*, *45*(2), 26–40.

Soucek, R., & Moser, K. (2010). Coping with information overload in email communication: Evaluation of a training intervention. *Computers in Human Behavior*, *26*(6), 1458–1466. doi:10.1016/j.chb.2010.04.024

Straumsheim, C. (2016). Read and unread. *Inside Higher Ed*. Retrieved from https://www.insidehighered.com/news/2016/03/02/study-explores-impact-social-media-texting-email-use

Szóstek, A. M. (2011). "Dealing with My Emails": Latent user needs in email management. *Computers in Human Behavior*, *27*(2), 723–729. doi:10.1016/j.chb.2010.09.019

Witzig, L., Spencer, J., & Myers, K. (2017). Social media: Online versus traditional universities and developing communities? *Journal of Higher Education Theory and Practice*, *17*(6), 39–52.

Zhang, S. (2018). Information overload and online collaborative learning: Insights from agent-based modeling. In *Proceedings of the 5th Annual ACM Conference on Learning at Scale*. Association for Computing Machinery.

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