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Digital transformation in higher education: the use of communication technologies by students

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Abstract

Considering the growing number of students accessing the Internet through mobile devices, universities have been increasingly interested in accepting new communication technologies in the teaching context, enhancing the digital transformation of these institutions. Thus, it becomes relevant to have instruments that allow the characterization of the use of these technologies in the context of higher education. This paper is the result of a more comprehensive research project and aims to analyze the students' perspective on the use of those technologies to communicate with their teachers, to investigate with what goals and functions students use the technologies, and to understand what their expectations are. To support the study, an analysis model was conceptualized and deployed in a case study conducted at a Portuguese university. Data collection was carried out through the administration of an online questionnaire to students in 2018. The results show that applications that allow interpersonal communication as well as publishing and sharing technologies are preferred by students to communicate with their teachers. In addition to the use, we analyzed the answers regarding the ease of use, expectation, attitude toward using, satisfaction, frequency of use, among other variables considered in the analysis model and presented in this paper.

Keywords: communication technology, expectation of use, higher education, students, technology acceptance.

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Introduction

The development of online based communication technologies (CT) has been changing the academic environment and contributing to the digital transformation in higher education institutions. In particular, they have been proving useful to increase the level of communication between students and teachers in the higher education arena [1] [2]. Although this type of communication has traditionally occurred mainly in the classroom, it is evident that nowadays it is not limited to such a place, and it can now occur at almost any place and any time [3], pressing students and teachers to accompany the renewal of the use of CT in contemporary society.

Some authors have acknowledged this pressure, saying that the development of innovation and technology in higher education must meet the needs of the rapid change taking place in the world [4]. Students use mobile devices to become more efficient in their day-to-day tasks and to renew their learning processes. Students have also become more autonomous due to the availability of information accessibility. Teachers have also changed their practices, taking advantage of the greater accessibility afforded by CT. However, this may also require more availability, as cases where students establish communication with their teachers at any time of the day, any day are frequently reported [5].

Universities and other similar institutions are expected to be concerned with developing and implementing technological communication infrastructures that will provide them with appropriate channels to communicate with their audiences. In addition, these communication technologies should provide students and teachers with the tools they need to facilitate their interaction so that the teaching and learning mission can be achieved [6].

A study whose general objective was to analyse the use of communication technologies between students and teachers in the teaching and learning process was conducted at the University of Aveiro, Portugal. The research question of this study is: how is the use of communication technologies between students and teachers in higher education characterized? In this paper we present the part of the results related to the use of CT by students, which is related to the following research questions:

- Research question 1: With what goals and functions do students use CT to communicate with their teachers?
- Research question 2: What are the students' expectations regarding the use of CT to communicate with their teachers?

Considering that most studies in the literature on CT use either Technology Acceptance Model (TAM) or Expectation Confirmation Model (ECM) to evaluate the users' engagement with technology, the main contribution and innovation of this study, compared to the existing literature, is the proposal of a more comprehensive analysis model based on both models and the presentation of some results of the first case study that used this analysis model. This also contributes to understand the role of CT in the digital transformation in higher education, and its impact on these institutions and their agents.

The literature review, briefly presented in the next section, addresses the use of CT in the higher education context, and the TAM and ECM models, which are used to develop the proposed analysis model. The methodology used is described and the data sample is characterized, followed by the presentation of the main results and the discussion of these against other known results. Finally, the conclusion and some future research directions are presented.

1. Literature review

In this section, some studies related to the subject are presented. They simultaneously support the analysis model conceptualized in this work as well as demonstrate the innovation and the contribution of this work, namely regarding the more comprehensive characterization of the use of CT in the higher education context. In the literature we find several studies on students and CT, in which the TAM is the most used model to investigate technology acceptance [7]. There are also some studies using ECM model to assess how much students are getting engaged with CT [8]. Some of those studies are described below.

A research about the university students' perceptions, attitudes, opinions and expectations of privacy and trust regarding electronic communications, such as e-mail, web browsing, use of social networks and other online

activities was conducted [9]. The facilitating medium, the impact on perceived privacy, the effects of institutional policies on follow-up and possible loss of privacy and trust were some of the variables analyzed, and the results showed that, in addition to the awareness of institutional policies, students perceived that their electronic communications within the university are private [9].

Considering that social media are present in a student's daily life and can therefore be an effective tool in supporting communications in the teaching context, with peers and with teachers, a research was conducted in order to examine the effects of social networks in collaborative learning [10]. The results from a questionnaire administered to students from a university in Turkey indicated that the perceived ease of use is a predictor of perceived usefulness and both have an impact on the use of social media by students for educational purposes. The use of social media improves peer interaction, interaction between students and teachers, and students' engagement. Other findings refer to peer interaction and involvement in the course, which have a significant positive effect on collaborative learning. These results can be beneficial to students and leaders of institutions in their ability to create initiatives to support, promote and encourage the implementation and use of social media in a virtual learning environment, providing appropriate experiences for teachers with increased adoption of social media [10].

Regarding Web 2.0 technologies, a very specific study [11] analyzed whether students, in the learning and education context, could benefit from the use of Wikis. The results showed that most students use Wikis because of the opportunity of collaboration, but also fear that the content can be unduly altered, and thus the authors concluded that students will not use Wikis even if it brings advantages.

Another study [12] on the evaluation of the perception of mobile technology, with support in TAM, confirmed that learning has been influenced by the evolution of technology, and due to the opportunities provided by mobile technology, the academic community has developed a better view on the implicit technology and how it is perceived and used by all. The fact that TAM was used helped to understand the opportunities, benefits and limitations of the technology that should be investigated in the use of academic learning [12].

An analysis, also supported by TAM, measured the success of students in using e-learning platforms, thus investigating their dependence, adoption and the integration of technology into academic activities. The results show that the students' perceptions of platform usefulness and ease of use are associated with the intention to use them effectively even when there are changes in the study routines. Therefore, the integration of e-learning platform functionalities into teaching-learning activities should be promoted and supported by the institutions [13].

2. Analysis model

In order to respond to the objective of this research, it was necessary to theoretically base the methodology, techniques and instruments of research in an analysis model. This analysis model was conceptualized aiming the characterization of the use of CT by students, including not only the use but also the expectation, and all the associated indicators. Thus, this section intends to present the model conceptualized to support this study.

The analysis model used is based on two concepts: Agents and Communication Technologies, as we can see in Table 1 [14]. The first concept concerns the personal characteristics of the agents, having the students as dimension. The indicators relating to students are their sex, age, the course they attend, the cycle of studies and the department they belong to. Communication Technologies are the second concept of this model, and its dimensions are their characterization, the use (based on TAM) and the expectation (based on ECM).

Describing the Characterization dimension, according to the first research question, it is intended to know, as indicator, the categories of CT used by students; more specifically, the applications they use to communicate with their teachers, and for which communication functions and/or objectives they use them.

The indicators presented in the Use dimension are the TAM constructs: the perceived usefulness; the perceived ease of use; the attitude toward using; the intention to use and the actual system usage. The selection of these indicators is because this theoretical model was developed and applied to study the acceptance and the behavior of users regarding the use of these technologies. Perceived usefulness refers to the degree of credibility of users regarding the use of the system and its contribution in improving their performance. Ease of use is understood as the individual belief that a given system will remain effortless at the time of use. In this context, it should be noted that the impact between perceived usefulness and ease of use originates effects on external variables that create the behavioral intention of use or non-use of these technologies [15], such as: system characteristics, development,

training and intention to future use. Attitude is the combination of increased user performance and subsequent rewards for the use of technology, while intention to future use is the purpose of the user to perform a procedure using technology in the future. And, finally, the actual use of the system refers to the frequency of use over a fixed unit of time [15] [16].

Table 1. Analysis model: the use of CT by students to communicate with their teachers

Research question 1:

With what goals and functions do students use CT to communicate with their teachers?

Research question 2:

What are the students' expectations regarding the use of CT to communicate with their teachers?

Concept	Dimension	Indicators
Agent	Student	Sex; Age; Course; Cycle of Studies; Department
Communication Technologies	Characterization	Categories used by objective or function
	Use (TAM)	Usefulness; Ease of use; Attitude; Intention to future use; Actual System Usage
	Expectation (ECM)	Usefulness; Confirmation; Satisfaction; Intention to future use

Regarding the Expectation dimension, the selected indicators are aligned with the ECM: the perceived usefulness; the confirmation; the satisfaction, and the intention of continuity. The perceived usefulness is the way users see the benefits of the system; the confirmation is the users' perception of the agreement between their expectation of the use of the system and their current performance; satisfaction is the feeling that the use of the system causes in the users; and finally the intention to future use refers to the intention of the user to continue using the system [17].

To accomplish this study it was necessary to adopt a CT taxonomy. The taxonomy presented in Table 2 is an adaptation of previous classifications [2] [14] and is organized into the following categories: applications for publishing and sharing content; applications that allow collaboration; applications that enable interpersonal communication; and social networks. Table 2 synthesizes this organization, showing the subcategories in which some categories are divided into and some examples.

Methodology

In order to implement this research, we chose to conduct an online survey, adopting a descriptive approach based on the data collected from the students' responses from the University of Aveiro to an original questionnaire based on the analysis model described in the previous section. The first part of this questionnaire includes a set of questions about the characterization of students whose main objective is to characterize the sample of data obtained, such as sex, age, the course they attend and the department they belong to. The second part includes a set of questions about the CT used by students to communicate with their teachers, another set of questions about accepting the CT (TAM indicators) and a final set of questions about the expectations of use (ECM indicators).

Table 2. CT Taxonomy

Categories	Sub-categories	Examples
Publishing and sharing technologies		Youtube, Moodle, Flickr, Blogs, etc.
Collaborative technologies		Google Drive, Slack, Wiki, etc.
Interpersonal communication	Electronic mail	Gmail, Hotmail, etc.

technologies	Instant messaging	Messenger, WhatsApp, SMS, etc.
	Videoconferencing and voice systems	Skype, Google Hangouts, etc.
Social networks		Facebook, Twitter, Linkedin, etc.

The questionnaire was implemented online and validated by performing pre-tests aiming to eventually improve the writing of questions or correction of implementation errors. The questionnaire was then applied to students from the University of Aveiro and was available between March 22 and May 9, 2018.

The answers to the questionnaire were prepared to be processed, resulting in a validated sample of n = 570 students (3.9% of all student population consisting of 14,703 students). The data sample analysis shows that more women (78.8%) than men (21.2%) responded; most students were under 20 years old (23.9%) or between 20 and 24 years old (44.4%); the majority of students attended bachelor's or master's degree (86.5%); the most represented scientific 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%). The results are described in the next section.

Results

In this section we describe the main results obtained from the students' responses to the online questionnaire. When students were asked about the CT categories they use to communicate with their teachers (yes / no), their answers (Table 3) show that electronic email technologies are by far the most frequently used option. All other CT categories show utilization rates below 20%, except for publishing and sharing technologies that are used by 38.1% of students.

Table 3. The CT used by students to communicate with their teachers

Categories	Sub-categories	Relative frequency of use
Publishing and sharing technologies		38.1%
Collaborative technologies		18.4%
Interpersonal communication technologies	Electronic mail	96.5%
	Instant messaging	17.4%
	Videoconferencing and voice systems	12.6%
Social networks		15.6%

There are two indicators that are common to the Use (TAM) and to the Expectation (ECM) dimensions, which make up the Communication Technologies concept of the analysis model. Thus, the results are jointly presented:

- Usefulness (TAM, ECM) [scale: not useful; little useful; neither useful nor useless; useful; very useful]: In general, students perceive the use of CT as useful or very useful, and they rarely mention the CT as being not useful. A relevant number of students gave neutral answers about the usefulness of videoconferencing and voice systems (18.1%) and of social networks (15.7%). The electronic mail systems are the most CT mentioned as useful (32.7%) or very useful (65.1%), but the aggregate numbers are not very different from the other CT (all above 80%);
- Ease of use (TAM) [scale: very difficult; difficult; neither difficult nor easy; easy; very easy]: Electronic mail systems and instant messaging systems are the two CT that students feel easier to use. In the first case, students feel it easy (35.8%) or very easy (60.5%), and in the second case they feel it easy (28.3%) or very easy (64.6%). All the other CT were subject to at least 14% of neutral answers, and the difficult or very difficult answers were not very relevant (all under 5%);

- Attitude (TAM) [scale: very bad; bad; neither bad nor good; good; very good]: The portion of students that feel they are underperforming using CT is very low, under 4% for all the categories considered. However, regarding the expectation towards the electronic mail systems (7.1%), students gave relevant numbers of neutral answers, between 12.1% (instant messaging) and 19.0% (collaborative technologies). The electronic email systems is the category that students considered they perform better (92.2% good or very good);
- Intention to future use (TAM, ECM) [scale: no; probably no; neither yes nor no; probably yes; yes]: Students show they are very keen to continue using CT, giving the electronic mail systems the highest score: 20.2% answered probably yes and 78.2% answered yes (98.4% in aggregate). The lower intentions to future use are observed in social networks (14.6% of negative answers) and collaborative technologies (10.5% of negative answers);
- Actual system usage (TAM) [scale: never; rarely; sometimes; often; always]: There are just two CT categories that at least 50% of students agree they use often or always: publishing and sharing technologies (40.6% often and 18.9% always; 59.5% in aggregate) and electronic email (41.1% often and 35.5% always; 76.6% in aggregate). In the specific case of electronic mail, just 3.3% of students mention they rarely or never use this technology. On the other hand, the other categories are much less used, especially the cases of videoconferencing and voice systems (34.7%), and of social networks (33.7%), mentioned by students as never or rarely used. These two categories also show high expressive numbers when the option sometimes was chosen (40.3% and 32.6%, respectively);
- Confirmation (ECM) [scale: totally disagree; disagree; neither agree nor disagree; agree; totally agree]: Students show, in general, that their expectations of using CT are in accordance with their current performance. This is especially evident in the case of electronic mail systems (86.4% agree or totally agree) and instant messaging systems (84.8% agree or totally agree). The lower confirmation level is related to the use of social networks, with 6.7% of students who disagree or totally disagree, and 23.6% of students with a neutral answer;
- Satisfaction (ECM) [scale: very unsatisfied; unsatisfied; neither satisfied nor unsatisfied; satisfied; very satisfied]: Higher levels of satisfaction are identified with the use of electronic email and instant messaging systems: 89.3% of students are satisfied or very satisfied with the use of electronic mail systems and 84.9% are also satisfied or very satisfied with the use of instant messaging. The lower levels of satisfaction are related to the videoconferencing and voice systems (7.0% unsatisfied or very unsatisfied) and social networks (6.7% unsatisfied or very unsatisfied). These two categories also show high levels of neutral answers (22.5% and 18.1%, respectively), as well as collaborative technologies (21.0%).

Discussion

Considering the results described, we can now answer the research questions.

Research question 1:

- Question: With what goals and functions do students use CT to communicate with their teachers?
- Answer: The results clearly show that the CT most used by students to communicate with their teachers are electronic mail systems (mentioned by 96.5% of students), that 76.6% of students use often or always. Also, 38.1% of students assume they use publishing and sharing technologies to communicate with their teachers, with 59.5% of students using them often or always. This latter result may be due to the case of using the Moodle LMS platform, institutionally provided by the University of Aveiro. All the remaining CT categories are used by less than 20% of students to communicate with their teachers. Particularly interesting is the fact that videoconferencing and voice systems, as well as social networks, are rarely used or not used at all by more than 30% of students to communicate with their teachers. All sum up it is evident that electronic mail systems are the most used CT, followed by publishing and sharing technologies (possibly to access to materials available on Moodle). This seems to confirm previous results [2] arguing that electronic mail systems may be currently replacing older systems of direct face-to-face communication with teachers, and also to replace the old paper-based copy system to get teaching support materials.

Research question 2:

- Question: What are the students' expectations regarding the use of CT to communicate with their teachers?
- Answer: The results seem to be consistent to argue that electronic mail and instant messaging systems are the CT that students mostly consider useful and easy to use, that they perform well, that satisfy them, that they intend to continue using in the future, and that fulfill their expected performance. This is evident in all the indicators considered (TAM and ECM). On the other hand, social networks and videoconferencing and voice systems are the categories associated with lower levels on those indicators, giving the idea that they are less interesting for students to use to communicate with their teachers.

In a holistic view, it is evident that electronic mail and instant messaging systems, as well as publishing and sharing technologies, have an important role on the communication between students and teachers. Even if the data is just about one university, more specifically the University of Aveiro, this is consistent with other available results [2], even if in other cases some differences depend on the type of study and the CT studied. However, some studies show that institutionally supported CT are more used by students than other CT [2], but this is not confirmed in this case.

Conclusion and future research

Recently, with the ease of access to the Internet and the high number of students with mobile devices able to communicate via the Internet, the paradigm of communication has been changing also in the higher education context. Hence, we can say that the CT are one of the factors of digital transformation that universities are experiencing. Thus, universities have increased their interest in accepting the use of different and sophisticated CT in the context of teaching in order to improve student participation in the educational process [18]. For example, it is increasingly evident that social networks are currently present in the students' daily life, and it is difficult to disconnect them from those networks, so changing teaching methods could bring more improvements to the incentive and engagement of students.

This study shows that students pragmatically choose the most appropriate CT to communicate with their teachers, not being clear if there is any institutional factor of influence. In fact, the results show students choose electronic mail, instant messaging systems and publishing and sharing technologies to communicate with teachers, not being evident whether the specific technologies chosen are institutionally supported. Also, the results show a low expectation regarding the use of social networks and videoconferencing and voice systems, although these systems are widely used on a daily basis for other purposes.

As future work, it might be relevant to confront the results of this study with the teachers' perspective or with a perspective of the institutional communication, as well as the evaluation of the communication overload perception in the context of higher education. The development of more specific studies on each application is also an interesting future work area in order to understand, for example, the reasons for using electronic mail more often instead of other applications that are available institutionally, and that are also easy to use and access.

In fact, the spread of the Internet that has occurred in recent years has made it regularly present and essential regarding the communication in most academic institutions and, more generally and transversally, in society. For this reason, it is not a question of whether the CT should be used, but rather the reason why the current CT influence the progress of the different forms of communication that are used by the actors in the educational process (students, teachers and educational institutions) and consequently the digital transformation of organizations. This influence that can be practiced on these stakeholders can generate a gap between the practices of communication accepted and adopted in the society and those that are accepted and adopted by the academic institutions.

Acknowledgements

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