A MODEL TO EVALUATE THE USE OF COMMUNICATION TECHNOLOGIES IN THE COMMUNICATION BETWEEN STUDENTS AND TEACHERS IN HIGHER EDUCATION

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Abstract

Nowadays, the use of technology as a means of communication between students and teachers has become common, but they should consider some premises so that there is efficient and effective communication between them. The use of communication technologies will only be successful if both share the same expectations of use, both in terms of communication efficiency and in satisfaction. Thus, it becomes relevant to have models of analysis that allow to evaluate the use of communication technologies in the most varied contexts, particularly in higher education. This paper presents and describes a model of analysis designed for a project which aims to characterize communication between students and teachers in higher education in the current digital era. This paper also presents some results, from a case study at a Portuguese university in which this model was used, allowing, from now on, to validate the presented model.

Keywords: communication, technology, higher education, model of analysis, technology acceptance, expectation, overload.

1 INTRODUCTION

Communication technologies (CT) have altered and revolutionized the academic path of students, thus creating new opportunities in the student-teacher relationship. If there were times when student-teacher communication was almost exclusively made in the classroom, today this relationship is broader, more varied and physically more distant, but it is more omnipresent [1].

It is also true that there is a concern of higher education institutions wanting to be connected with their public, to have the best infrastructure and access to CT [2]. A student's success in the digital age may depend on a variety of factors, such as their interaction with the teacher or the use of the technology offered by institutions. However, the extent of communication possibilities and associated technologies is so vast that sometimes students and teachers may perceive information and communication overload, which can lead to communication failures in this relationship [3], and generate problems in the context of teaching and learning [4].

It is therefore relevant to understand that available CT are provided by the higher education institutions and how students and teachers use them to communicate with each other, and what expectations they share when using them. In this way, a research project has emerged under the following research question: "How can we characterize the use of CT in the communication between students and teachers in Higher Education?". In order to respond to this broader objective, three more specific research questions were created:

- Research question 1: With what goals and functions do students use CT in communication with their teachers?
- Research question 2: What are the expectations of students regarding the use of CT in communication with their teachers?
- Research question 3: Do students and teachers perceive information and communication overload when they use CT to communicate with each other?

The objective of this paper is to present the model of analysis that support all methods, techniques and instruments conceptualized to conduct this research and to allow find answers to the research questions. This model, supported by the Technology Acceptance Model (TAM) and by the Expectation Confirmation Model (ECM), enable the evaluation of the use of CT in the communication between
students and teachers in higher education, regarding the dimensions of use, expectation and perceived overload.

The literature review, briefly presented in the next section, addresses the use of CT in the higher education context, presenting some studies supported by the TAM and the ECM. Then, the model of analysis is described. The methodology used is also presented, as well as some main results from a case study in which the model of analysis was applied. Finally, the conclusion and some future research directions are presented.

2 LITERATURE REVIEW

In this section, some studies related to the subject are presented, supporting the model of analysis presented in the next section and demonstrating the innovation and the contribution of this work, namely regarding the more comprehensive characterization of the use of CT in the context of higher education. The use of TAM appears in several studies in the higher education context to analyze the technology acceptance [5]. There are also some studies using ECM model to assess how much students and/or teachers are getting engaged with CT [6].

It is likely that individuals who engage with a new technology and realize that this new system brings benefits, accept it and use it in the future. It was exactly on the basis of this assumption that the ECM was expanded by [6], based on the Expectation Confirmation Theory developed by Oliver [7], being widely applied to examine the intention to continue to use the technology, instead of just explaining the users' satisfaction. Although the model name includes expectation, the pre-consumption of expectation is replaced by expectation of post-consumption [8].

The ECM includes dimensions about the continuance intention, such as: perceived usefulness, confirmation of expectations and satisfaction. The users' continuance intention is determined by their satisfaction with the use of and by the perceived usefulness of the continuous use of the technology. User satisfaction, in turn, is influenced by the confirmation of the expectations of prior use and perceived usefulness. The post-acceptance perceived usefulness is influenced by the level of user confirmation [6]. The approach to this model is important because the dimensions addressed will be one of the most important focuses of this research. If the expectations of the students and teachers are positive, according to this model they will accept the technologies and continue to use them in their relationship in the future.

The relevance of the approach to the theory/model to complement the selected studies has brought good results in many cases, which can be concluded that it is important to include these two models (TAM and ECM) to ensure a better result. There is always an intention or acceptance of the use of technologies by those who aspire to make effective use of a technology. On the other hand, less good results have also been obtained, which may lead to the conclusion that there are other factors that may be causing these more negative results.

A study was conducted to analyze the university students' acceptance of statistical learning platforms in order to aid in the learning of these statistics, but in a virtual learning environment [9]. Digital resources such as simulations, videos and online questionnaires were provided on the platform. Supported by the TAM, the researchers conceptualized a corrected model consisting of four external conditions which could influence students' perceptions and the acceptance to the platform, such as self-efficacy, simplifying conditions, subjective norm, and anxiety. The results showed that the intention of the students to use the platform was affected by their attitude towards the platform, which was later influenced by the perceived usefulness.

Another study was carried out on the acceptance of students in the adoption and use of information and communication technologies (ICT) in an object-based learning module using the TAM [10]. The objectives of this research were to determine whether TAM is a valid model to explain students' intentions to use ICT tools and to recognize the determinants of this behavior. A total of 737 students completed an online questionnaire with 13 items supporting the constructions of the model, thus achieving perceived ease of use, perceived usefulness, attitude towards use and intention to use. From the data analysis, they indicated that the perceived ease of use significantly influenced the perceived usefulness; both perceived ease of use and perceived usefulness, significantly influenced the intention to use; and perceived usefulness and attitude toward use have significantly influenced the intention to use.
A study related to the desire for e-mail to improve productivity and organizational efficiency [11], observed some e-mail experiences through semi-structured interviews, in order to evaluate the effects of e-mail on the user [12]. Participants indicated that they felt controlled by e-mail, and this behavior made them uncomfortable because they could not optimize their potential and productivity in the use of e-mail simply because they could not handle all the e-mails received.

Another study on information and communication overload in social networks, allowed to realize that the Japanese users who use the Twitter had to deal with the stress derived from this informational and communicational overload [13]. The study was based on two actions: investigate the activities of people who are not part of a group of friends and the changes in the methods of processing tweets. The following variables were observed: the number of friends; the overload perception; and the methods of processing tweets. The results indicated that users who experience overload continue to increase the number of friends but have changed their usage habits to avoid received tweets. In other words, users did not select a strategy to decrease incoming tweets, but instead changed the processing method for incoming tweets.

Other studies confirm the existence of information and communication overload in contemporary universities, and the lack of adequate e-mail management strategies is one of the main reasons [14], [15].

In the above studies it is demonstrated that there is e-mail overload it is a reality for which a solution has not yet been obtained. The issue of overloading is something that bothers the academic community because there is excessive information, often unnecessary, which forces most of the time to manage and filter the information considered important for what is considered unimportant. In this sense, higher education institutions should create easy and simple solutions and mechanisms to help with this existing overload and then optimize the information and communication processing. It is believed that, because there is overload, a student can more easily look for a social network, which has a less formal and faster access.

It is also perceived that e-mails play an essential role in the university world, but there is little information about the management strategies used to minimize this problem. It is also true that a teacher experiences information and communication overload more easily than a student, because the number of students is larger, it is the one-to-many relationship. It is also relevant to mention how the higher education (like the society) is constantly changing in terms of technology and ways of communicating, so what is considered habitual should take on new routes and stimuli to the communities involved.

3 MODEL OF ANALYSIS

This work was developed with the general aim of contributing to the characterization of the use that the higher education students and teachers make of CT to communicate with each other. In order to achieve this goal, we considered the points of view of the students and the teachers, from whom the data were collected. An original model of analysis [16] was created to systematize the concepts involved in this problem in order to identify a set of appropriate indicators to collect data from students and teachers. This model, and in particular its indicators, is the basis for the development of the data collection instrument described in the following section.

The model of analysis, shown in Table 1, was elaborated based on two essential concepts: the agent concept, in which the dimensions of the students and of the teachers were considered; and the concept of the CT, explored in the dimensions of its characterization, acceptance of use (TAM), the expectation of use (ECM), and the perception of information and communication overload.

The first concept concerns the personal characteristics of the agents, having as dimensions the students and the teachers. The indicators relating to students are their gender, age, the course they attend, the cycle of studies and the department they are affiliated with. In the case of teachers, the indicators of sex, age and the department they are affiliated with, as well as their scientific area (according to the Scientific Council of the University of Aveiro) are considered.

Communication technology is the second concept of this model. This concept is explored in four dimensions. The first dimension is the characterization of CT which are used in communication between students and teachers, and that is directly related to research question 1. Based on several previously published proposals [17], [18], in this study we adopted the taxonomy of CT shown in Table 2, which are used in collecting data on indicators which allow us to perceive for which different communication functions and / or objectives they use CT.
Table 1. Model of analysis to evaluate the use of CT in the communication between students and teachers in higher education

**Research question 1:**
With what goals and functions do students use CT in communication with their teachers?

**Research question 2:**
What are the expectations of students regarding the use of CT in communication with their teachers?

**Research question 3:**
Do students and teachers perceive information and communication overload when they use CT to communicate with each other?

<table>
<thead>
<tr>
<th>Concept</th>
<th>Dimension</th>
<th>Component</th>
<th>Indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agent</td>
<td>Student</td>
<td>Sex; Age; Course; Cycle of studies; Department</td>
<td></td>
</tr>
<tr>
<td>Teacher</td>
<td></td>
<td>Sex; Age; Course; Scientific area; Department</td>
<td></td>
</tr>
<tr>
<td>Communication technology</td>
<td>Characterization</td>
<td>Categories used by objective or function</td>
<td></td>
</tr>
<tr>
<td>Acceptance of use (TAM)</td>
<td></td>
<td>Usefulness; Ease of use; Attitude; Intention to future use; Actual system usage</td>
<td></td>
</tr>
<tr>
<td>Use expectation (ECM)</td>
<td></td>
<td>Usefulness; Confirmation; Satisfaction; Intention to future use</td>
<td></td>
</tr>
<tr>
<td>Overload perception</td>
<td>Communication</td>
<td>Quantity; Processing capability</td>
<td></td>
</tr>
</tbody>
</table>

Table 2. CT Taxonomy.

<table>
<thead>
<tr>
<th>Categories</th>
<th>Sub-categories</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Publishing and sharing technologies</td>
<td></td>
<td>Youtube, Moodle, Flickr, Blogs, etc.</td>
</tr>
<tr>
<td>Collaborative technologies</td>
<td></td>
<td>Google Drive, Slack, Wiki, etc.</td>
</tr>
<tr>
<td>Interpersonal communication technologies</td>
<td>Electronic mail</td>
<td>Gmail, Hotmail, etc.</td>
</tr>
<tr>
<td></td>
<td>Instant messaging</td>
<td>Messenger, WhatsApp, SMS, etc.</td>
</tr>
<tr>
<td></td>
<td>Videoconferencing and voice systems</td>
<td>Skype, Google Hangouts, etc.</td>
</tr>
<tr>
<td>Social networks</td>
<td></td>
<td>Facebook, Twitter, Linkedin, etc.</td>
</tr>
</tbody>
</table>

The second dimension, which is directly related to research question 2, is the acceptance of use, based on the TAM, which is a theoretical model that has been developed and applied to study the acceptance and behavior of users in the use of technologies. This model addresses the relationship between usefulness, perceived ease of use, and the intent to use a technology, and is used to explain why users accept or reject information technology [19]. TAM provides a basis for external variables that influence belief, attitude, and intention to use. According to TAM, the actual use of a technology system is influenced directly or indirectly by the user with behavioral intentions, attitude, perceived usefulness and perceived ease of the system. The model also considers that external factors affect the intention and the actual use, through effects that result in perceived usefulness and perceived ease of use. This model has been used to find explanations about students’ intentions regarding the use of ICT technologies and the intention to continue this use [10].

Davis et al. [19] refer to constructs integrated in the TAM, which we consider as indicators of this dimension. Perceived usefulness refers to the level at which users realize the improvement of their performance as a result of the contribution of the use of a system. A perceived ease of use refers to the users’ perception of the level of effort they have to perform when using a system. It is important to note that the relationship between perceived usefulness and ease of use gives rise to effects on external variables that create the behavioral intention to use or not use technology [20]. Variables such as the
characteristics of the system, its development process, users training and intention to use may create this behavioral intention of use or no [19]. Attitude is the combination of the increased performance in the use of a system and the rewards that can result from such. The intention to future use refers to the users’ availability in relation to their behavior, that is, in relation to the possibility of using a given system in the future. Finally, the current use of a system refers to the frequency with which the user uses the system, that is, the use in relation to a given period of time [19], [20].

The third dimension, which is also directly related to research question 2, is the expectation of use based on the ECM. It is likely that individuals who engage in a new technology and realize that this technology brings benefits, accept and use it in the future. It is based on this assumption that the ECM was expanded by [21], based on the Expectation Confirmation Theory [7]. This model has been applied to examine users’ intention to continue using information systems rather than just explain the satisfaction that results from their use [22]. The inclusion of ECM in this model of analysis is important: if the expectations of students and teachers on the use of CTs are positive, they will accept these technologies and continue to use them in the future in their communication relationship. Based on the ECM constructs, four indicators were selected. Two are similar to indicators already considered in the dimension of acceptance of use, namely the perceived usefulness and the intention to future use. Two other indicators were added: confirmation, which refers to the possible alignment between the users’ expectation on the use of a system and their own performance when using the same system; and the satisfaction that users may feel as a consequence of the use of a given system [23].

Finally, the fourth dimension is the perception of information and communication overload, and it is directly related to research question 3. The information overload has been referred in relation to the amount of information that one can digest. To a certain extent, the increase in available information is beneficial for decision-making. However, if the available information goes beyond a certain point, the ability of individuals to use it decreases and can provoke symptoms of information overload [24]. In addition to the amount of information, other variables have been associated with the occurrence of information overload, such as the quality of the information or the frequency with which the information is made available to the user. Recently the issue of communication overload has also been addressed as a consequence of the characteristics of the current communication processes, which are massive and require a permanent availability of users. The phenomenon of communication overload is difficult to dissociate from information overload, and so information and communication overload has recently been used in several publications [25], [26]. As our study is about communication more than information issues, in this dimension we considered only the communication component, having been selected two indicators, the quantity and the capacity of communication processing, in order to analyze the amount of messages exchanged between students and teachers, as well as the effort required to process the communication, using the various categories of CT indicated in Table 2.

4 METHODOLOGY

This research was carried out through a quantitative approach. Based on the model of analysis, an original questionnaire was prepared with specific versions to teachers and students. The first part of this questionnaire includes a set of questions about students and teachers to characterize the data sample obtained. The second part includes four sets of questions about the CT used by students and teachers to communicate with each other: which categories of CT are used by objective or function; questions about accepting CT (TAM indicators); questions about the expectations of use (ECM indicators); and questions about the overload perception students and teachers may have using CT.

Although the model of analysis and the research instruments were conceptualized so that they could be used in any context of higher education, in this research they were applied to a case study at the University of Aveiro. The questionnaire was implemented online, subjected to pre-tests, and was used for data collection between March and May 2018. A total of n = 570 student responses (3.9% of the student population, 14,703) and n = 172 teacher responses (16.5% of the teachers population, 1,044) were validated.

The students data sample shows that more women (78.8%) than men (21.2%) responded; the students were mostly 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 cycles of studies were the bachelor / first degree (46.1%) and the master degree (31.1%); and that the most represented departments were those of biological sciences (14.7%) and health sciences (12.8%). The teachers data sample shows that more men (56.1%) than woman responded (43.9%); the ages of teachers were normally distributed, with the highest percentage in the age group from 45 to 49 years of age (20.9%);
the most represented scientific areas were the health sciences (11.6%) and the mathematic sciences (9.9%); and that the most represented departments were those of health sciences (12.2%) and communication and the arts (10.5%).

The two data samples were processed using statistical descriptive techniques. Also, inference tests were used to test the independence of the two data samples. Test results were considered significant when the test value was equal to or lower than a significance level of $\alpha = 0.05$.

5 RESULTS

In this section a short insight of results is described. About the first research question, it turns out that students and teachers frequently use CT to communicate with each other (Table 3). In particular, electronic mail systems are used by almost all students and teachers. Other CT are also widely used, namely publishing and sharing technologies. In general, teachers recognize using more often than students the CT to communicate with each other.

<table>
<thead>
<tr>
<th>Categories</th>
<th>Sub-categories</th>
<th>Relative frequency of use by students</th>
<th>Relative frequency of use by teachers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Publishing and sharing technologies</td>
<td></td>
<td>38.1%</td>
<td>72.7%</td>
</tr>
<tr>
<td>Collaborative technologies</td>
<td></td>
<td>18.4%</td>
<td>23.8%</td>
</tr>
<tr>
<td>Interpersonal communication technologies</td>
<td>Electronic mail</td>
<td>96.5%</td>
<td>96.5%</td>
</tr>
<tr>
<td></td>
<td>Instant messaging</td>
<td>17.4%</td>
<td>29.1%</td>
</tr>
<tr>
<td></td>
<td>Videoconferencing and voice systems</td>
<td>12.6%</td>
<td>32.6%</td>
</tr>
<tr>
<td>Social networks</td>
<td></td>
<td>15.6%</td>
<td>25.6%</td>
</tr>
</tbody>
</table>

About the second research question, it was observed that in general the expectations of use of the CT are similar between students and teachers. In particular, and considering the dimensions of accessibility and use expectation, the results on the indicators show that:

- Usefulness: in general, of students and teachers consider the use of CT to be useful. Similar expectations have not been obtained just in the case of the use of videoconferencing and voice systems;
- Ease of use: no relevant situations were identified in which students and teachers had difficulty in using the proposed CT, and similar expectations were not observed just in the case of the use of electronic mail, where teachers consider it easier to use than students;
- Attitude: in general, students and teachers showed similar expectations regarding their performance in the use of the CT indicated;
- Intention of future use: students and teachers have shown different expectations regarding the future use of publishing and sharing technologies and of instant messaging systems. In both, teachers are more willingly to use them in the future than students;
- Actual systems usage: in all but the instant messaging systems, students and teachers shown different expectations in terms of use frequency. In all of five CT categories, teachers were found to be more frequently used than students;
- Confirmation: students and teachers do not confirm, in any of the CT categories considered, that they have similar expectations about their use. Confirmation is greater for teachers than for students in most categories, except for instant messaging systems;
- Satisfaction: in general, students and teachers are satisfied with their use of CTs to communicate with each other. Their expectations are similar in every CT category except in the case of publishing and sharing technologies, where teachers are more satisfied than students.

About the third research question, the following results are obtained on the selected indicators:
Quantity: students and teachers perceive different levels of communication overload caused by the number of messages exchanged in cases of use of electronic mail systems and videoconferencing and voice systems. In both cases, the perception of communication is higher by teachers than by students;

Processing capability: students and teachers perceive distinct levels of communication overhead in terms of their effort to process the messages exchanged in the cases of electronic mail and videoconferencing and voice systems. In both cases, the perception of communication overload is higher by teachers than by students.

6 CONCLUSIONS

The main focus of this paper was to present an original model of analysis to support research that allows to characterize the communication between students and teachers in higher education. The model is supported by the literature on the subject, in particular by the literature on TAM and ECM, and by the literature on information and communication overload. The model was applied at the University of Aveiro, Portugal, and no aspects of the analysis model were found that would indicate the need for its improvement. The data samples obtained include a high number of validated responses. The results show that students and teachers effectively use the CT to communicate with each other, highlighting the high frequency of use of the categories of CT that include tools available institutionally, namely publishing and sharing technologies and electronic mail systems. The remaining CT categories are less commonly used, but the results show that students and teachers are familiar with them and, in general, they are positively related to them. Thus, encouraging the adoption of new user practices can contribute to satisfying the willingness, demonstrated by the results, to continue to use them. The application of the model of analysis in other cases, possibly with a wider scope, is important to extend the validation of the model. In particular, it seems interesting to apply this model to the Portuguese public higher education institutions, in order to extend the knowledge already acquired by other studies of national scope in the area of the use of the TC by the students and teachers of these institutions [17].

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