Chatbots and messaging platforms in the classroom: an analysis from the teacher’s perspective

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Abstract
Introducing new technologies such as messaging platforms, and the chatbots attached to them, in higher education, is rapidly growing. This introduction entails a careful consideration of the potential opportunities and/or challenges of adopting these tools. Hence, a thorough examination of the teachers’ experiences in this discipline can shed light on the effective ways of enhancing students’ learning and boosting their progress. In this contribution, we have surveyed the opinions of tertiary education teachers based in Spain (mainly) and Spanish-speaking countries. The focus of these surveys is to collect teachers’ feedback about their opinions regarding the introduction of the messaging platforms and chatbots in their classes, understand their needs and to gather information about the various educational use cases where these tools are valuable. In addition, an analysis of how and when teachers’ opinions towards the use of these tools can vary across gender, experience, and their discipline of specialisation is presented. The key findings of this study highlight the factors that can contribute to the advancement of the adoption of messaging platforms and chatbots in higher education institutions to achieve the desired learning outcomes.

Keywords: Chatbots; Messaging platforms; Tutorship; Educational bots; Higher education

1 Introduction
The introduction of new technologies in the classroom, to be successful, involves extra teacher training, devising methods for enhancing student engagement with the new technology, and indeed acquiring new skills by students and teachers alike. Some technologies are readily adopted, but others require longer time for full adoption. In most cases, the magnitude of the uptake of the new technology impinges on the collaboration of all the parties using it. Hence, examining the users’ opinions is an important first step in boosting this collaboration and reaping the benefits of the technology. Recently, a surge in the use of synchronous instant messaging tools in higher education such as WhatsApp, Telegram and Facebook Messenger took place. Some messaging applications have built-in chatbots to support a synchronous conversation between the different parties [Studente et al., 2020], while other chatbots are developed as standalone systems and can possibly be attached to a messaging application using an API (Application Program Interface).
A chatbot is a program, sometimes developed using Artificial Intelligence techniques, able to communicate in a similar way as humans do [Gong, 2008], using, in some cases, natural language. Indeed, most of these applications would be, apparently, close to passing a classic Turing test [Moor, 2003], since they are able to answer almost any question fluently, and even pose own questions in their conversations. The recent advancement in this discipline has played an important role in many fields especially in education and online tutoring [Clarizia et al., 2018, Smutny and Schreiberova, 2020]. These automatic systems facilitate the delivery of personalized learning by adapting to students’ pace of learning and providing customized online tutoring outside the classroom. Thus, chatbots can significantly contribute to providing interactive learning experiences as well as improving individual attention [Agarwal and Wadhwa, 2020]. In this sense, chatbot technology offers a great opportunity for the improvement of tutoring systems [Daniels, 2016, Agarwal and Wadhwa, 2020], as not all students are comfortable with face-to-face tutoring with the instructor. In fact, in many cases, some students experience stress because of their need to ask a question in front of the entire class. This is why many students resort to silence in the classroom and tend to contact their teachers later via email. Consequently, this can lead to not only a delay in obtaining answers to their questions but can also cause a significant increase in their teachers’ workload, especially when factoring in the disproportion between the class size and the number of teachers. Hence, the chatbot technology has a potential to mitigate this problem by providing answers to students’ questions and facilitating a dynamic and autonomous learning experience [Griol et al., 2014, Kim, 2020]. In addition, using an automated system such as a chatbot, can draw teachers’ attention to topics that students struggle to comprehend or need further assistance in understanding.

Given the potential benefits that chatbots could bring to the classroom, the focus of the EDUBOTS KA2 European project [1], the sponsor of this study, is to explore best practices and innovative use of chatbots, and to create a learning community of educators in higher education institutions. The majority of studies conducted so far have studied how these messaging applications and/or chatbots are used to deliver personalized learning in classrooms that occurs anytime anywhere, promote collaborative learning experiences, group discussions [Panah and Babar, 2020] and boost students’ sense of belonging to their institutions [Abbas et al., 2021b]. Hence, due to the paucity of research that explores the use of these technologies from the teachers’ perspectives, this paper aims to investigate their opinions/needs and the challenges/opportunities of adopting these technologies in classrooms to paint a better picture of how they can positively contribute to enhancing the learning process in higher education institutions.

In this study, data collection involved two phases:

- The first phase aimed to collect feedback from students about their actual information about students’ preferences of tools/applications for chatting and messaging, how they use them in educational context, who do they like to be with in the class messaging groups, and their expectations of the chatbots in terms of assisting them during their learning process. Therefore, two surveys
for bachelor and master degree students at the University of Granada (Spain) were designed and answers from more than 250 students were collected. The key findings of the students’ surveys reveal that they prefer to use messaging applications, such as Telegram or WhatsApp as they are familiar to them. Students also expressed interest in chatbots that can assist them with organizing their course schedules, help them access their assignment grades and facilitate searching for course’s resources.

- The results of the first phase were fed into the second phase of the study, which focused on teachers’ opinions about using chatbots and messaging applications in classes. This is what is going to be presented in this paper.

Initially, a single survey was developed for this purpose and responses from 300 higher education teachers were collected and analysed; this will be explained more fully in the methodology section. The responses’ analysis entailed the creation of a second survey to which 200 teachers’ responses were collected, with the methodology and collective characteristics that will be explained below. The questions of the second survey focussed on discussing teachers’ needs, opinions and preferences of the development of future technology-enhanced tools and its potential impact on educational institutions’ policies. In order to assess these, this paper investigated the following research questions:

- RQ1 - Are teachers already using messaging apps in their classes?
- RQ2 - Which chatbots’ features would teachers find useful in their classes?
- RQ3 - Which kind of interaction do teachers prefer with their students?
- RQ4 - What kind of interaction media features do teachers value the most?

We will try to answer these questions through the analysis of questions and answers in the two surveys. Eventually, what we want to obtain is a series of recommendations to make a successful deployment of chatbot technologies (and, in some cases, general instant messaging applications) in higher education; from the response to RQ1 and RQ4 we will try to recommend specific technologies or applications to be used in the classroom; the response to RQ2 and RQ3 will help us recommend chatbots features or specific platforms; and finally, from RQ3 we will also try to find best practices in the adoption of messaging platforms and they accompanying chatbots.

The remainder of the paper is organized as follows: first, an overview of what current research has found about the use of messaging applications, including chatbots, in the classroom is described. The methodology used in the surveys is presented in Section 3, and the results of the surveys are presented next in Section 4. Finally, we discuss these results and conclude with a series of recommendations in the section that closes the paper.

2 State of the art

The widespread and rapid adoption of free Mobile Instant Messaging (MIM) tools/platforms such as WhatsApp, Telegram, WeChat and Facebook Messenger stems from their simplicity, ease of use and multi-modality (i.e. video, audio, text) [Tang and Hew, 2017]. Using these tools in higher education can facilitate the delivery of personalised learning that occurs anytime anywhere, promote collaborative learning experiences and group discussions [Panah and Babar, 2020].
WhatsApp is, at least in most Western countries, the most popular MIM platform used by educators to provide assignments’ feedback to students, support course discussions, and provide learning resources in informal learning settings [Panah and Babar, 2020]. Moreover, the use of WhatsApp in higher education could enhance social presence [Tang and Hew, 2017] and foster trust relationships between educators and students embedded in the social learning process [Gachago et al., 2015]; however, this last paper also reflects the need for learners to “take ownership of the tool” and the advantages of social learning in general. At the same time, it also mentions different challenges, among which the most important is the blurring of social and academic life; indeed, there are challenges when using MIM tools that occur due to the blurring of boundaries between academic and private life. This can lead to technostress [Gachago et al., 2015], difficulty in managing responsibilities, especially among mature students, and lack of privacy [Tang and Hew, 2017]. Students’ dropout of the MIM groups, as they can leave groups at any time, can hinder their learning and undermine educators’ efforts [Mwakapina et al., 2016]. In addition, there is a need to set rules and norms for these MIM groups in order to maintain the safety of these online communities for students [Abbas et al., 2021b]. However, these rules should not affect students’ ownership and control, since it is vital to advance in their learning [Gachago et al., 2015] process. This is why examining the role of MIM in higher education is still a challenge, and why the opinions of the teaching community towards them have to be examined, as we do in this paper.

The use of MIM, although possibly valuable by itself, can be enhanced via the use of chatbots, which, being conversational agents, usually dwell in systems where synchronous conversations take place. The use of conversational agents (chatbots) in higher education is still at its infancy [Yang and Evans, 2019]. Nevertheless, recent studies examining their positive impact on students’ academic performance [Pérez et al., 2020] and engagement [Studente et al., 2020, Abbas et al., 2021b] have led to a growing interest in using this technology in the (possibly virtual) classroom. Indeed, the use of chatbots in collecting course feedback from students in higher education improved students’ response quality and boosted their enjoyment levels [Abbas et al., 2021a]. According to [Roblyer et al., 2010], using either tools such as mobile devices or teaching strategies based on gamification [Yildirim, 2017] can improve student motivation. In this sense, the authors in [Pimmer et al., 2019] adopted a quasi-experimental, survey-based approach to report the positive impact of using instant messaging tools in boosting students’ knowledge and mitigating their feelings of isolation.

Several higher education chatbots’ evaluation studies have been undertaken. For instance, a recent evaluation review study presented by Smutny and Schreiberova [Smutny and Schreiberova, 2020] examined 47 educational chatbots implemented in Facebook Messenger with the focus to identify characteristics and quality metrics such as language, subject matter and platform, whereas the study undertaken by Pérez and collaborators [Pérez et al., 2020] aimed to categorise educational chatbots, according to their, purpose into service-oriented and teaching-oriented. The first category includes those that provide service support such as the chatbot Ask Holly [Durham University, 2021] and Dina [Santoso et al., 2018];
both chatbots respond to students’ questions about enrolment and registration. Ask L. U. [Lancaster University, 2019] answers students’ frequently asked questions about timetables, grades, tutors and societies. LISA [Dibitonto et al., 2018] and Differ [Studente et al., 2020] facilitate breaking the ice between new students by introducing them to each other. Ranoliya et al. [Ranoliya et al., 2017] proposed a generic chatbot for university students that is able to answer to their frequently asked questions and, for some time, the University of Granada had Elvira as a chatbot in its main web page [Moreo et al., 2012] to perform that duty. Besides being able to answer pre-established (frequent) questions, it did so from the website of the University of Granada using an inset persona, voiced by a real person, who lip-synced the answers. The emphasis in the case of Elvira, however, was on the authenticity of the synchronization more than in making the update of questions answered simpler, or more interactive, or more open to the rest of the university staff, using actual messaging platforms. In most cases, the embedded search engine was able to provide more up-to-date and accurate answers than the ones provided by Elvira, which had to be updated by hand (and not too often). It was eventually discontinued, and its technology was not adapted to other platforms, since it did not really provide an useful service. Its service was not tied to teaching anyway; it was more related to directory queries and university-wide administrative questions, so even if it is strictly an example of a chatbot in a university setting, it is not really a chatbot that can be adopted by teachers to affect the learning outcomes, something which is the focus of this paper.

On the other hand, teaching-oriented chatbots are more sophisticated, as they set personalised learning outcomes and monitor learning progress. For instance, [Fernoagă et al., 2018] reported on “eduAssistant”, a virtual teaching assistant chatbot developed on the Telegram messaging platform. In this study, the Telegram platform is chosen because it is easy to use, students are familiar with its features, and it enables them to exchange messages in different formats (text, audio and video) [Fernoagă et al., 2018]. In addition, Telegram could operate on all devices and operating systems. The “eduAssistant” chatbot acts as an automatic agent in teacher-content-student, facilitating real-time feedback loops and providing a personalised learning experience relevant to the students’ acquired skills and knowledge. Using this chatbot, educators can create interactive instances in their lectures where they pose questions to their students and the chatbot assists those who need further help by giving them more hints and reporting it to their educator’s dashboard [Fernoagă et al., 2018]. This can help educators locate those students that need more attention and send them more educational resources relevant to their academic attainment. In addition, a recent study has analysed how the use of chatbots positively affected the learning outcomes of students in a Chinese class [Chen et al., 2020].

Despite its (arguably) successful implementation in different higher education institutions, over all in the fringes of educational activity, not in the actual student-teacher interaction, its implementation or deployment is not trivial. Some authors, for instance [Sjöström et al., 2018] have proposed a conceptual architecture for the adoption of teaching-oriented chatbots in higher education. This conceptual architecture is based on a systematic literature review of previous studies, examining
the design of chatbots in higher education, as well as making a content analysis of student emails and discussion forum posts of four instances of a Java programming course. The study outlined several design considerations; among them, the authors emphasised the importance of developing chatbots in platforms that students and educators are familiar with and can easily access (i.e. Facebook Messenger) which was confirmed with [Hobert, 2019] and [Fernangá et al., 2018] studies. In addition, [Sjöström et al., 2018] argued that a conceptualisation of learners’ questions could aid designers in integrating the appropriate types of questions that the chatbots should support for different courses. Some other authors, like [Coronado et al., 2018], proposed agents that store learning materials to be provided on demand to students, whereas the authors in [Crockett et al., 2017] reported on tutoring systems, which can perform initial assessments of students’ understanding and provide learning material that would advance their understanding to the next level.

Regarding the factors for the adoption of chatbots in higher education, many studies have focused on the evaluation of technology acceptance and usability [Roblyer et al., 2010, Pimmer et al., 2019]. However, higher education is a special domain where, according to [Hobert, 2019], specific pedagogical factors such as learning success and increased motivation are more important. Therefore, to develop effective chatbots for higher education, all stakeholders’ (i.e. educators, students, institutions, etc) needs should be carefully collected and taken into consideration [Sjöström et al., 2018, Tsivitanidou and Ioannou, 2020]. These needs include, but are not limited to, student’s learning success due to higher motivation, but these are a posteriori effects that cannot be assessed in advance; this is why we focus in this paper on what the teachers are looking for in a TAM (Technology Acceptance Model) and associated technologies like chatbots; both authors focus on what the teachers need in terms of the latter; this paper will focus on a wider perspective trying to ascertain what they are looking for in terms of general messaging technology. The classical literature [Moore and Benbasat, 1991] already proposes that any adoption of technology must be tuned in to the user needs and experience. In this paper we will try to find out what those are in order to propose a successful model of adoption of chatbot technology.

Along this line of research, our previous work [Mora et al., 2021] aimed at analysing the expectations of students on this regard; recent papers have also analysed how the use of chatbots affected the learning outcomes of students in a Chinese class [Chen et al., 2020]. This paper analysed conversational chatbots in an one-to-one setting, finding that learning really benefited from it. This is, once again, a proof of the benefit of chatbots in certain settings; however, there are some prior experiences, as well as needs that might prevent the successful acceptance of the technology, and these are what we are trying to find out in this paper, together with what kind of features would improve its acceptance.

Besides, the present work is focused on the other key actor in this challenge, i.e. educators. How they accepted chatbots has been studied very recently by Chocarro et al. [Chocarro et al., 2021], who, by analysing surveys, created a technology acceptance model that proposed a series of features that would make chatbots easier to accept; among them, formality of language as well as easiness and usefulness. The
survey targeted primary and secondary education teachers, and was also more interested in the general use of chatbots in education, not specifically in a classroom setting, seeking educational outcomes. However, they establish a series of results that are obviously interesting and relevant for this work.

We will present next the methodology we have followed to find out teachers’ opinions.

3 Methodology
This study followed a quantitative approach towards addressing its research objective, by collecting rich data about the use of messaging applications and chatbots by educators in both universities and colleges[2]. To achieve this goal two online surveys were designed and developed using Google Forms in Spanish. They are comprised of six questions focusing on demographic data (i.e., sector, gender, degrees, discipline, age, teaching experience) followed by several multiple choice questions allowing the participants to choose multiple answers.

In the first survey, the multiple choice questions are focused on the use of messaging apps in the teaching practice, the type of chatbot use cases that teachers consider useful for their teaching and the impact of COVID on the teaching practice; please check them out to the full extent in the Appendix.[3]

This survey was piloted by the authors of the paper and their colleagues before using it in the study. All the comments collected from this trial were incorporated in the survey. We mainly used mailing lists, as well as Telegram groups, to post the survey link to reach out to more educators. The university form was sent to Spanish (mainly Andalucía and Galicia) universities, and also universities in Costa Rica and Mexico. The tertiary (non-university/college) teachers were based mainly in Andalucía. Dissemination and answers took place in the first quarter of 2021, during the Covid-19 pandemic and while, at least in Spain, many universities had mandatory virtual teaching.

A total of 282 teachers responded to the survey: 193 teaching at the University (68.4%) and 89 at other tertiary education institutions (31.6%). From those, 179 indicated their gender as male (63.5%), 98 as female (34.8%) and 5 teachers preferred not to indicate their gender (1.8%). In terms of age, the majority of the participants (n=111) in this survey was 45-55 years old (39.4%), while 91 teachers were 35-45 (32.3%), 46 were 25-35 (16.3%) and 34 teachers were older than 55 (12.1%). Last, 84 teachers had a teaching experience of 16-25 years (29.8%), 75 teachers 6-15 years of experience (26.6%), 69 teachers had 0-5 years of experience (24.5%) and finally, 54 teachers had more than 25 years of teaching experience (19.1%).

Responses were stored automatically in a Google Drive spreadsheet. Eventually, the results from the two forms we used for the first survey were collated in a single spreadsheet. Survey questions are shown in Appendix I (Section 8).

[2] In Spain, they are called simply high schools, and deliver tertiary or associated degrees that do not have the consideration of university degrees
[3] This first survey was made in two separate Google forms, one for university and the other for teachers in tertiary education institutions, outside the university system (vocational training, including 1- and 2-year degrees). Questions and responses were the same, except for the type of tertiary degrees that were considered.
The second survey was designed after initial results to the first survey arrived, and pointed to necessities and experiences of teachers not being addressed by the first one; namely their experience with messaging platforms and the way they were used to interact with students. It was piloted in a group of university teachers attending to a formation course, and validated with them. It was then extended to the rest of the responders, using the same media: Telegram groups, email and announcement in mailing lists. The questions asked in that survey are also shown in Appendix I (Section 8).

A total of 205 teachers responded to the second survey: 187 graduate teachers (91.2%) and 18 student teachers (8.8%). From those, 124 were male (60.5%), 65 female (31.7%) and 16 teachers preferred not to indicate their gender (7.8%). In terms of age, the majority of the participants (n=70) was again, as in the first survey, 45-55 years old (34.1%), while 67 teachers were 35-45 years old (32.7%), 42 were 25-35 (20.5%) and 26 teachers were older than 55 (12.7%). In terms of teaching experience, 59 teachers had a teaching experience of 16-25 years (28.8%), 51 teachers had 6-15 years (24.9%) and 0-5 years of experience (24.9%), and 44 teachers more than 25 years of teaching experience (21.5%).

Next, we show the results and analyse them.

4 Results and analysis
We collected responses from 282 teachers from Spain and Spanish Speaking countries for survey1 and 205 for survey2. The two forms were open for approximately the same amount of time, around two months. The sample includes mostly teachers from university, although about 32% and 8% are from non-universitary tertiary education in the first and second survey respectively. Regarding gender, 61% of the teachers were male and 32% female, while approximately 5% chose not to disclose it. Finally, the responses are more or less equally distributed according to the teaching experience, showing 24% of responses from teachers with 5 or less years of experience, 26% for 6-15 years of experience, 30% for 16-25, and 20% for teachers with more than 25 years of experience.

We will try to find the answers to the four research questions next, by analysing the response to the different survey questions.

4.1 RQ1 - Are teachers already using messaging apps in their classes?
Group messaging apps have become a powerful tool for communicating with students. Also, many of them have built-in chatbots to enhance the learning process. After an initial analysis to the answers to the first survey, we realized that there were some prior issues mainly related to the adoption of a technology, i.e. chatbots, that generally piggybacks on another, i.e. messaging applications. Generally, in a technology adoption model, perceived ease of use and perceived usefulness are essential. But it is going to be very difficult for teachers to find chatbots easy to use if they, previously, do not consider, or simply use, the messaging tools to which they are attached.

This is why for answering RQ1, teachers were queried about whether they use messaging apps in their classes, specifically, Telegram, WhatsApp, Slack (an application used mainly in IT departments and software development), or any other messaging
app, and whether they use messaging apps provided by their academic institution (see Table 1). Overall, the majority of the teachers responded that they do use messaging apps in their classrooms, from which apps (or, more probably, messaging solutions) provided by the academic institution (n=159, 56%) and WhatsApp (n=124, 44.0%) were the most common responses. Only 19 teachers (6.7%) replied that they do not use any messaging app in their class.

| Messaging App          | Yes | %  | No  | %  |
|------------------------|-----|----|-----|----|
| Telegram               | 62  | 22.0| 220 | 78.0|
| WhatsApp               | 124 | 44.0| 158 | 56.0|
| Slack                  | 15  | 5.3 | 267 | 94.7|
| Other                  | 60  | 21.3| 222 | 78.7|
| Provided by the Academic Institution | 159 | 56.4| 123 | 43.6|
| None                   | 19  | 6.7 | 263 | 93.3|

Table 1 Use of messaging apps to assist the learning process.

Results in Figs. 1, 2, 3 do not show significant differences in the use of instant messaging apps between teachers from University and vocational education. In general, most teachers prefer messaging apps provided by their own institutions (we also show the results for the two most popular messaging app platforms: WhatsApp and Telegram). With respect to specific disciplines, Engineering and Technology teachers are more active in their use, but the number of teachers from Humanities who answered they used these apps in their classes is also remarkable (around 60% use the apps provided by their institutions).

Although no significant differences were found regarding gender, female teachers answered they use instant messaging apps more than male teachers (about 10% more). Also, teachers in vocational Education use WhatsApp more than university teachers. Regarding the distribution of the use of messaging apps per age, there are no significant differences for WhatsApp and apps provided by their own academic institutions. However, younger teachers also use Telegram with more than 25% responding they do, a percentage that falls to about 10% for teachers that are 55 or older. One interesting result is that about 65% of teachers with more than 25 years of experience use the platforms provided by their institutions while the percentage goes down to less than 50% for teachers with 6-15 years of experience.

Some of the questions in the survey were focused on the impact of the COVID19 pandemic between the 2020 and 2021 academic years in the teachers’ attitudes towards the use of instant messaging apps in their class. Our main intention in this case was to assess whether a crisis will bring about some kind of change in the use of tools. The 282 answers are summarized in Figs. 4, 5, 6, 7, showing that about 77% of teachers already used these tools before the pandemic and kept using them during the pandemic lockdowns that forced students and educators to use remote education schemes. Moreover, approximately 15% of them switched their messaging app for one that offered a safer interaction with their students. According to the responses, an additional 16% started using messaging apps during the pandemic for the first time in their classes.

A chi-square test of independence was performed to examine the relation between instructors’ discipline, sector, and gender and any potential changes that occurred
Figure 1 Use of messaging platforms either external or provided by the teachers’ academic institutions in class: distributions per gender, years of experience in education, university or vocational education, and discipline.

Figure 2 Use of Whatsapp in class: distributions per gender, years of experience in education, university or vocational education, and discipline.
Figure 3 Use of Telegram in class: distributions per gender, years of experience in education, university or vocational education, and discipline.

Figure 4 Total count of responses for the use of messaging apps after the COVID-19 pandemic grouped by gender (PNTS stands for Prefer Not To Say).

Figure 5 Total count of responses for the use of messaging apps after the COVID-19 pandemic grouped by sector.

Figure 6 Total count of responses for the use of messaging apps after the COVID-19 pandemic grouped by years of experience in teaching.

Figure 7 Total count of responses for the use of messaging apps after the COVID-19 pandemic grouped by discipline.
to the use of messaging apps due to the covid-19 pandemic. The relation between the latter variable and the instructors’ sector was significant, $X^2_{(4,N=282)} = 9.598, p = 0.048$. The frequencies cross tabulated are given in Table 2. In effect, this finding indicates that how teachers responded to the use of messaging apps during the pandemic and in particular, whether they changed their habits in the use of apps for teaching purposes, was related to their sector (university vs vocational).

| Post-covid changes | University (f) | Vocational (f) | Total |
|--------------------|---------------|----------------|-------|
| Yes, I use a safer messaging app now | 27 | 13 | 40 |
| Yes, I didn’t use any messaging app before, but do use it now | 31 | 13 | 44 |
| No, I did use it before and use it now | 105 | 60 | 165 |
| No, I didn’t use it before and don’t use it now | 22 | 2 | 24 |
| Total | 193 | 89 | 282 |

**Table 2** Sector * post-covid changes cross-tabulation

The majority of the teachers (n=165) mentioned that no changes in their habits occurred due to the emergency remote teaching, as the use of messaging apps was part of their teaching practices and remains the same, from which 105 teachers come from the university, and 60 teachers from the non-universitary tertiary sector. The relationships between changes in the use of messaging apps, due to the covid-19 pandemic, and the instructors’ discipline, $X^2_{(24,N=282)} = 44.856, p = 0.006$, as well as the gender, $X^2_{(8,N=282)} = 16.249, p= 0.039$ were also significant. This finding indicates that how teachers responded to the use of messaging apps during the pandemic was also related to their gender and discipline. In fact, from the majority of the teachers who did not change their habits in this respect (n=165), most of them are males (n=114), and come from the technology (n=60) and engineering (n=53) disciplines (see Tables 3, 4).

| Post-covid changes | Male (f) | Female (f) | PNTS (f) | Total |
|--------------------|---------|------------|---------|-------|
| Yes, I use a safer messaging app now | 20 | 20 | 0 | 40 |
| Yes, I didn’t use any messaging app before, but do use it now | 20 | 23 | 1 | 44 |
| No, I did use it before and use it now | 114 | 47 | 4 | 165 |
| No, I didn’t use it before and don’t use it now | 18 | 6 | 0 | 24 |
| Other | 7 | 2 | 0 | 9 |
| Total | 179 | 98 | 5 | 282 |

**Table 3** Gender * post-covid changes crosstabulation

Finally, we took a closer look at the post-covid changes and the variables gender, sector, and discipline for which the chi-square test is statistically significant as shown in Figures 8, 9, 10 respectively. Each figure shows on the left, a graph that represents the Pearson’s residuals of the chi-square test results and a table on the right part that shows the contribution of each cell to the test. In the Pearson’s
residual graphs, the responses to the question about the use of messaging apps were shortened for the sake of clarity according to: 1) Did/do stands for Yes, I did use it before and do use it now; 2) Didn’t/do for Yes, I didn’t use any messaging app before, but do use it now; 3) safer for Yes, I use a safer messaging app now; 4) Didn’t/Don’t for No, I didn’t use it before and don’t use it now.

Table 4 Discipline * post-covid changes crosstabulation

| Post-covid changes                          | Engineering (f) | Social Sciences (f) | Sciences (f) | Biomedicine (f) | Humanities (f) | Technology (f) | Other (f) | Total |
|--------------------------------------------|-----------------|--------------------|-------------|----------------|----------------|----------------|-----------|-------|
| Yes, I use a safer messaging app now       | 7               | 11                 | 5           | 5              | 1              | 10             | 1         | 40    |
| Yes, I didn’t use any messaging app before, but do use it now | 13              | 12                 | 5           | 4              | 2              | 7              | 1         | 44    |
| No, I didn’t use it before and use it now  | 60              | 26                 | 20          | 4              | 0              | 53             | 2         | 165   |
| No, I didn’t use it before and don’t use it now | 14             | 4                  | 1           | 2              | 1              | 1              | 1         | 24    |
| Other                                      | 8               | 0                  | 1           | 1              | 1              | 0              | 9         |       |
| Total                                      | 99              | 53                 | 32          | 16             | 5              | 72             | 5         | 282   |

Figure 8 Analysis for gender and post-covid changes: left) Pearson’s residuals for the Chi-square test; right) Gender*post-covid changes crosstabulation, including standardized residuals [Agresti, 2013] (also adjusted standardized residuals) and contribution percentage to the total Chi-square test of each cell.

As mentioned, the graphs on the left hand side represent the Pearson’s residuals, showing the difference between the observed and the expected values for each cell. Thus, large residuals indicate that variables are not truly independent. In our case, the blue shows positive contributions and red negative contributions to the test. Moreover, the saturation shows how large the contribution is in contrast to the expected value by chance. Additionally, tables on the right side show adjusted standardized residuals that according to [Agresti, 2013], if greater than +/-2 for cases with few cells, indicate lack of fit of $H_0$ (in boldface in our table). Complementary, the table also shows the percentage of contribution to the test of each cell (highest percentage per column also in boldface).

Regarding gender in Fig. 8, the results show a high positive contribution from female educators that did not use a messaging app before the COVID-19 pandemic but do use it now; approximately 31% of the test results are explained by this cell. In contrast, male educators that respond the same were less than expected (negative contribution that explains 17% of the test results). Also, it is important to highlight the female educators that kept using these apps before and after the pandemic and
correspondingly the negative contribution of male educators to the same case (less than expected by chance). 

With respect to the sector, the results in Fig. 9 show a positive contribution from university educators being reluctant to use any messaging apps before or after the pandemic: the positive contribution of their responses explain 25% of the test results with an adjusted residual of 2.94. On the contrary, vocational teachers were more open to it, showing a negative Pearson’s residual. Also, we find larger values than expected in vocational teachers that kept using these apps after the pandemic. 

Finally, statistical significance was found for the discipline and post-covid changes. Regarding disciplines (see Fig. 10), the number of educators from Humanities and Social Sciences that started using messaging apps after the pandemic is larger than expected and these number of responses explains about 19% of the chi-square test results. Also, the number of educators from Technology or Engineering that started using safer alternatives [4] are less than expected (compared to the educators from

\[\text{This addresses the issue of insecure/unsafe applications which do not encrypt messages or can be easily compromised exposing information}\]
other disciplines). Bear in mind that some disciplines were merged to avoid very low number of responses for some of the cells.

4.2 RQ2 - Which kind of chatbots would teachers find useful in their classes?

For answering RQ2, teachers were provided with a list of different potential chatbot functionalities (use cases) and were requested to respond on whether each given use case would be useful in their classes. The findings are summarized in Table 5.

| Chatbot use cases              | Yes | No  |
|-------------------------------|-----|-----|
|                              | Frequency | %    | Frequency | %    |
| Answering to students’ FAQs   | 148  | 52.5 | 134       | 47.5 |
| Assigning student grades      | 113  | 40.1 | 169       | 59.9 |
| Facilitating agenda information | 171 | 60.6 | 111       | 39.4 |
| Sharing class materials       | 136  | 48.2 | 146       | 51.8 |
| Others                        | 25   | 8.9  | 257       | 91.1 |

Table 5 Perceived useful chatbot use cases

The most favourable use case for chatbots in Higher Education and vocational training is their use for the facilitation of an agenda formation (171 positive response, 60.6%), followed by the FAQs use case (148 positive responses, 52.5%) and the sharing class material use case (136; 48.2%). A chi-square test of independence was performed to examine the relation among participants’ preferences for particular chatbot use cases. Out of the 171 teachers who consider useful the use of chatbots for agenda preparation in the class, 103 also consider useful chatbots’ use for FAQs. The relation between agenda and the FAQs use case was significant, $X^2_{(1, N=282)} = 10.467$, $p = 0.001$. The frequencies cross tabulated are given in Table 6.

| FAQs | Total |
|------|-------|
|      | Yes   | No    |      |
| Agenda | 103   | 68    | 171  |
| No     | 45    | 66    | 111  |
| Total  | 148   | 134   | 282  |

Table 6 Agenda use case * FAQs use case crosstabulation

Answers to these questions are plotted in Figs. 11, 12, 13, 14 grouped by gender, sector, years of experience in education, and discipline respectively. As it was a multiple choice question, the counts are over the total number of people that answered.

4.3 RQ3 - Which kind of interaction do teachers prefer with their students?

Since chatbots are intended to mediate or help in this interaction, it is essential to understand the kind of interaction teachers prefer. Chatbots should address those modes, and not others. In order to find out these modes, and thus answering RQ3, teachers were provided with a list of different kind of interactions that may take place among students and between students and the teacher, with the use of messaging apps. The findings are summarized in Table 7.

As it can be seen by the answer to the first and last question, in general teachers do not want to participate in a chat group with students; either they want to simply leave the students alone in their own chat group, or otherwise they prefer not to be part of that interaction. In general, that is going to be the case no matter what;
Figure 11: Count of types of chatbots for class perceived as the most useful for teachers grouped by gender (PNTS stands for Prefer Not To Say).

Figure 12: Count of types of chatbots for class perceived as the most useful for teachers grouped by sector.

Figure 13: Count of types of chatbots for class perceived as the most useful for teachers grouped by experience.

Figure 14: Count of types of chatbots for class perceived as the most useful for teachers grouped by discipline.

Figure 15: Distribution of teachers’ preferences for the chat groups with their students: from groups only with their students from a specific course to groups with greater social interaction with all students in their School or Faculty.
| Kind of interactions                                                                 | Yes | Yes | No  | No  |
|------------------------------------------------------------------------------------|-----|-----|-----|-----|
| Chat interactions among students in the same course                                | 166 | 59.1| 115 | 40.9|
| Chat interactions among students, teachers of the School/Faculty                   | 19  | 6.7 | 266 | 94.3|
| Chat interactions among students of the same study year and teachers                | 58  | 20.5| 224 | 79.4|
| Teacher not being part of the interaction                                           | 81  | 28.7| 201 | 71.3|

Table 7 Kind of interactions preferred

it is well known that students organize their own chat groups with many (and not always conveyable) intentions, so teachers do not want to take any part in these informal or non institutionally-supported chat groups. Overwhelmingly, they do not want to participate in these kind of chat groups with students, but even less so if it includes the rest of the faculty.

The answer, then, to this research question, is that, in general, teachers do not want to have interaction with students in a chat group. To a certain point, this would seem to contradict results [Gachago et al., 2015], although this might be due to cultural attitudes, or other factors such as the average size of classes. It does confirm, however, that the challenges cited in that study, and possibly others, are an obstacle to the adoption of mobile (and other) instant messaging among the community of surveyed teachers.

Regarding the social factor of chat groups that teachers use in class, according to Fig. 15 the vast majority prefer small groups only with the students from the same course. These are more focused groups with specific goals and dedicated to the organization of the course and its tasks, and from the pedagogic point of view it also seems more appropriate to improve the learning process. Interestingly, and as a cross-check of the answers above, about 30% of teachers consider they should not be part of the chat group. This might seem to contradict the results of the other survey, but in fact, being a result of different surveys, to a certain point affirms the same thing: there is a great amount of teachers that would be against being in a chat group with students. However, students will still need to get the services that the university, through chatbots, provide, thus opening the door for deployment of chatbots without the intervention of the professor, simply tapping university provided services [Bernier et al., 2002]. Whether that’s a slim majority or not, that’s open to debate (and would probably need a more pointed survey focused on this), but what is clear is that forcing teachers to create chat groups with students and participate in them would create a certain amount of resistance. Also, only university teachers find interesting a group with all the students and teachers in their own Faculty or School. The lack of teachers from vocational education here may be the consequence of using specific language such as “Faculty”. Moreover, the fact that many universities and schools already use these groups for administrative and social interaction (e.g. [Dibitonto et al., 2018]) might be the reason for the low percentage of teachers that selected this response.

4.4 RQ4 - What kind of interaction media features do teachers value the most?

As it can be seen in the table, the bulk of responders express their wish to use a sustainable and official application, i.e. both being approved or provided by the
Table 8 Interaction media features valued by teachers. Details about each of these features can be read in Appendix I (Section 8, second survey).

| Interaction features | Yes | No |
|----------------------|-----|----|
|                      | Freq. | % | Freq. | % |
| Analytics            | 108  | 52.7 | 97  | 47.3 |
| Connectivity         | 119  | 58.0 | 86  | 42.0 |
| Familiarity          | 121  | 59.0 | 84  | 41.0 |
| Hidden Phone Number  | 113  | 55.1 | 92  | 44.9 |
| Horizontality        | 134  | 65.4 | 71  | 34.6 |
| Official formation   | 42   | 20.5 | 163 | 79.5 |
| Pluggability         | 65   | 31.7 | 140 | 68.3 |
| Sustainability       | 157  | 76.6 | 48  | 23.4 |
| Unidirectionality    | 27   | 13.2 | 178 | 86.8 |
| Officiality          | 150  | 73.2 | 55  | 26.8 |
| Synchrony            | 45   | 22.0 | 160 | 78.0 |
| Other                | 5    | 2.4  | 200 | 97.6 |

Table 9 Interaction media features analysis (**p < 0.001, *p < 0.01, *p < 0.05). Columns and rows with no significant interaction have been suppressed for clarity. Every cell value represents $X^2$ ($1, N=205$). Details about each feature can be read in Appendix I.

Finally, a two-step cluster analysis was conducted, with a log-likelihood distance measure adopted, to explore how the use cases could be grouped based on their
preferences of specific interaction media features, and which features have larger predictor importance for the clustering (see Fig. 17). Two clusters occurred from the analysis: cluster 1 (n=78, 60.9%) is formed with instructors who did not value interaction media pluggability, connectivity, official formation, but valued interaction media analytics, familiarity, support by the institution; cluster 2 (n=50, 39.1%) groups instructors that did not value media analytics, official formation, familiarity, but valued pluggability, connectivity, and support by the institution. Interaction media pluggability appears to have the most important predictor importance in the clustering of cases (predictor importance = 1.0), whilst media unidirectionality was the least important factor (predictor importance = 0.04). The cluster quality is fair, but not a good one (silhouette measure of cohesion and separation).

![Figure 17](image-url)  
**Figure 17** Two-step cluster analysis for interaction media features: predictor importance

5 Discussion
Our initial intention in the design of these surveys was to probe the opinions of tertiary education teachers in the introduction of chatbot technologies in class. We wanted to find the answer to four research questions, of which the first was to check whether teachers already used some kind of messaging application, and the one they preferred. Depending on the answer, different technologies could be (or not) available for the introduction of chatbots. In this case, the design of the survey introduced some ambiguity on what we really consider “messaging technology”, that was eventually resolved by the answers; apparently, anything that sends messages (even if they are not instant, even if they do not have a dedicated application) was the concept in the mind of the surveyed. In this case, we would like to add a clarification.
While we had in mind, as indicated by the possible answers, instant messaging applications when we elaborated this question, we included these institution-provided applications mainly for completion. But it should be noted that, in most cases, they are not *instant* messaging apps in the way Telegram or Facebook Messenger are; in most cases they are messaging facilities provided by learning management systems such as (usually) Moodle. So the answer to this question must be understood in two different ways: their preference for the *provider* of the technology (the university itself, any company) as well as the *type* of technology (instant, app based messaging systems vs. web-based messaging systems integrated in another learning management system).

This inclusion of university-provided messaging applications in the survey might explain why there are so few, just 6.7%, that answer they do not use any messaging application. In general, universities provide official channels to communicate with students official academic information such as the exam schedule or the grades. The statistical mode is to use that kind of messaging. Some other people might not use it, but use some extraofficial or opt-in channels such as the other included in the survey; at the end, between these official and extraofficial channels most people cover their needs to communicate with students. This matches our subjective experience, in general.

Additionally, the question on COVID reflected the big challenge that represents changing habits, even in the case of a major crisis. Very few responders actually changed their habits, although comparing women vs. men as well as those teaching social sciences show some significant difference. We do not have any kind of explanation for this behaviour, other than technologies are perceived, and adopted, in a different way depending on background and, apparently, gender.

One of the most interesting questions that can arise from the analysis of the results, and that should require further study, is: Are teachers really aware of the possibilities of chatbots in the classroom? The survey only listed a few functionalities for the chatbots and just a few subjects selected the option "Others". This may suggest that most teachers did not really understand at this point the actual potential of chatbots, since the responses listed were by no means exhaustive, and if the responders were more acquainted with the possibilities of the technology, possibly this response would have shown up many more times. Another way to look about it is that, unless you provide the specific instructions on how to use a tool, the teaching staff is already too busy or burn out to think about innovation.

We can speculate that their opinions towards chatbots are informed by negative experiences with customer support chatbots, which is what most people will have experienced. This will probably require further study, but also will need to be taken into account when introducing chatbot technologies in the classroom: it will have to be as simple, and as satisfactory, as possible, to (possibly) change this existing perception.

Regarding gender grouping, both genders agree in their uses, so it seems not relevant at all. When looking at the plot containing the sector differentiation it is interesting to observe how university teachers prefer in a higher proportion to use them for grades and FAQs in comparison with other tertiary education teachers. This seems reasonable as the frequency of seeing the students is lower at the University so, an automatic tool for grade notification for continuous evaluation seems
more helpful. Furthermore, the high student/teacher ratios that university teachers have to deal with could be another reason to have a higher number of them willing to use chatbots for FAQs. This could ameliorate the number of misunderstandings and email overload that so many students might generate.

The results, when grouping by experience, confirm that experienced teachers are not afraid of changes and are willing to accept new technological challenges; at least, in the same way that younger teachers are. From this concrete plot it is interesting as well to observe the fact that very few young/inexperience teachers are willing to use chatbots for other uses. This reinforces the hypothesis thrown at the beginning of this section that younger teachers have less experience to consider new ways of using chatbots in their daily work.

As it appears in the responses presented above, teachers’ responses are equally distributed between positive and negative in relation to the media features: analytics, connectivity, and hidden phone number; that is, none of them is a prevailing factor on choosing one technology over another. However, for the features: familiarity, horizontally, sustainability and officiality the majority provided a positive response, designating their preference to these features. On the other hand, the majority of teachers seems to consider not valuable the presence of official formation, pluggability, unidirectionality and synchrony in the interaction media features of messaging apps.

From a qualitative point of view, these results show consensus in a few key aspects:

- Teachers want to have support from their corresponding institution. This is probably due to the strict European data regulations on data protection, but also to avoid the overhead required to sign up new students every year. In general support from specific formation and access to IT help desk for specific features enhances the possibility of adoption by the teachers or the possibility of a successful adoption that improves the learning outcomes. This is supported by the result of the two surveys: they prefer whatever "messaging" application is provided by the university, and also they value sustainability as well as "officiality" of the platform, as shown in Table 8.

- Teachers need sustainability. The main reason is that implementing changes is expensive in terms of effort and prone to errors in the first years of implementing new procedures, therefore, it is logical that if chatbots or messaging platforms are to be introduced, they want this change to be as permanent as possible.

- Keep it Simple. Media interaction requirements are simple and only a 2.4% is requesting more features. This could be a sign of technological burn out produced by the previous and current courses where, due to the pandemic, the use of computer has increased significantly.

An analysis of survey questions related to RQ4 seems to indicate that teachers prefer to share an interaction space with their student, as shown in Tables 7 and 8, where a majority of responders indicate they don’t want unidirectional communication; a preference of horizontal interaction, but also the answer to the kind of chatbots preferred that features FAQ bots prominently, which might indicate a need to delegate or offload part of the burden of answering, and attending, every single question posed by students. In an horizontal setting, other students can answer
if the teacher does not do it immediately. This might also be the reason why the possibility of using tools from which analytics can be extracted is also valued by teachers: that way, activity in the chat tool, answering questions, regularity, can all be observed and valued as part of the process of assessing achievement of learning objectives by students.

6 Conclusions

The key findings of this study shed the light on educators’ preference to use messaging applications that their institutions support. Technology adoption literature often focuses on users’ perceptions of the technology’s usefulness and ease of use as important prerequisites for successful adoption and utilization. Nevertheless, in higher education, institutions’ role in integrating these tools to their educational systems can improve the uptake of these applications and shape the social and educational experiences of their students. To accomplish this fruitful integration, institutions have to ensure that these messaging applications not only are GDPR (General Data Protection Regulation) compliant to keep students’ data secure, but also should provide IT support to all stakeholders who use the applications.

Comparing these results with those obtained in student surveys in [Mora et al., 2021], we have understood better the differences between the teachers’ points of view and/or intentions and that of their students when using the messaging applications in higher education. Teachers tend to adopt technologies supported by their institutions. The fact they do so could be caused by a desire to ensure that their universities can oversee their efforts in supporting their students during the learning process. Another reason could be their familiarity with the technology provided by their institutions. On the other hand, students use the non-institution messaging applications to form informal discussion groups with their peers. It is worth noting that peer support and collaboration is inseparable from learning [Timmis, 2012] and correlates positively with higher retention in higher education [O’Boyle, 2014]. Therefore, both perspectives are complementary and play different roles in promoting the learning process.

As in many other methodologies that try to assess technology acceptance, answers to the survey suggest that the introduction of simple, and institution-supported, instant messaging and chatbot technologies would increase the perceived usefulness (which is one of the key metrics in technology acceptance models). Since most institutions already have some virtual campus or learning management system, adding some easy automation, or connection to personal instant messaging tools, could really help onboard the learning community on these new technologies.

What we are going to propose next is a possible process of technology introduction that is compatible with the conclusions of this study, but that would have to be piloted in order to check its value, and its relationship with better learning outcomes, as well as higher teacher satisfaction. Once that initial introduction of institutional messaging automation tools is done, teachers (and students as well) will probably prefer the kind of bots that alleviate bureaucratic or repetitive tasks, such as answering frequent questions or answers on class or assignment deadlines, as indicated by their answers to the respective questions. These will help the introduction of more complex chatbots that will affect more directly learning outcomes,
such as chatbots that help students integrate in the class, or are able to identify (and address) learning problems in students or in groups of them. These should also be accompanied by analytics on student interaction, as well as possibly some natural language processing (in vernacular language) that will help assess the general mood of the class, and how different material (or external factors) affect it.

This introduction of chatbots and chatbot technology will be helped by the fact that no discernible differences are found between different groups. Even if chatbots do have some potential for personalization or customization, based on the class material, student and teaching staff, the general introduction of the technology can be done in a general way and for all disciplines, teaching experience and gender.

In our survey, we could not find an answer about the right moment introducing chatbot technologies. Response to questions related to change of behaviour during and after the first, stay at home, stage of the pandemic do not suggest that major (or minor) crisis could be an opportunity to introduce new technologies, since it does not bring major changes in attitude. A minor crisis would be, for instance, rollout of a new higher education law[5], or introduction of new degrees. Although external changes do offer the chance of piloting new technologies, they do not seem to bring changes in attitudes in the teaching staff (which, after all, is bound to be the same). In absence of a clear answer in this direction, the right moment to introduce new technologies is always when the IT and managing staff is ready to support it (since, as we have seen before, "official” support is one of the factors that is most valued by teachers).

At any rate, the general feeling that transpires from the survey is that it is essential for any institution to take into account the shareholder’s opinion when introducing chatbots. This is true almost across the board, but in the case of chatbots (and instant messaging applications) their immediacy and the fact that they can enter into what we could call the private sphere makes this even more necessary.

One of the questions we made in the second survey, related to the messaging applications used by tertiary education teachers, opens a new line of inquiry about what they perceive as such, and about how it is used. Namely, the responses indicated that the teachers perceived as messaging application not only what is usually called a chat or instant messaging app such as WhatsApp or Microsoft Teams, but also the means provided by the university for communicating with the student, such as a feature of grading applications that will email the grade to the student. This implies that there is a need by teachers, communication with students, also mostly unidirectional, and that it does not matter so much how that need is covered. However, this will need careful consideration, including how it ties with the automation of the learning experience that the chatbots bring.

There are several future lines of work informed by our results of this survey. For instance, the rollout of extensive videoconferencing and virtual teaching solutions that the COVID pandemic has brought has also taught us a series of lessons. It increases isolation, for instance, and decreases the amount of synchronous contact that happens in the fringes of the classroom: teaching staff offices, before and after class. A future line of work would be focused on exactly this, and what kind of needs

[5] We seem to have one of these, at least in Spain, every 10 years or so.
could be covered by chatbot technology. We will create a series of international surveys that will investigate this.

Finally, the full extent of chatbot technology is not really being examined in these surveys. They can be connected to natural language processing engines with sentiment analysis as well as other analytics. Examining the mood of the class, as response to new material, assignment, exams or external events might help will help any student-centred teaching strategy, which will help students (and teachers) reach their learning objectives. This line of work, however, will be based on the introduction of some pilot study, combined with initial opinion assessment on the students.

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7 Declarations
7.1 Availability of data and materials
The datasets generated and analysed during the current study are available in the edubots-paper repository, accessible from https://anonymous.url

7.2 Competing interests
The authors declare that they have no competing interests.

7.3 Funding
This work has been supported by EDUBOTS project, funded under the scheme Erasmus + KA2: Cooperation for innovation and the exchange of good practices - Knowledge Alliances (grant agreement no: 612446).

7.4 Authors’ contributions
All the authors have contributed to the study presented in this manuscript. (Rest hidden for double blind)
JJM has been the leader, drafted the first versions of the survey and supervised the writing of the manuscript. PAC has revised the paper and researched the state of the art, as well as contributed to the survey design. AMM has revised the paper and researched the state of the art, as well as contributed to the survey design. FB has made the revised the paper and researched the state of the art, as well as contributed to the survey design. AMM has revised the paper and researched the state of the art, as well as contributed to the survey design. FB has made
analysis and processed data and contributed to the survey design. NA has supervised the state of the art, and written the bulk of it, as well as contributed to discussion and conclusions. OT has performed data analysis, and contributed to discussion and conclusions. AG has contributed to the design of the survey, analysis, discussion and conclusions. All authors have read and approved the final manuscript.

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8 Appendix I: Survey questions
The surveys have the same common initial demographic questions:

- Degrees or titles where the teacher was working, either university or other tertiary education.
- Discipline: Engineering, Social Sciences, Health and Bio, Sciences, Humanities, Other.
- Gender: Man, Woman, Rather not say.
- Age: 25-35, 35-45, 45-55, more than 55.
- Experience on the job: up to 5 years, 5-15 years, 15-25 years, more than 25 years.
- Type of degree: university, other tertiary education.
- Gender: Man, Woman, Rather not say.

The first survey, shown in its original form in Figure 18, which focused on the use of messaging apps in class, includes the following questions:

1. Regarding the use of messaging apps in class, you prefer ...
   - A chat group with the students in the same course
   - Students self-organize and with the teacher not being part of any chat group
   - A chat group with all the students and teachers of the School/High-School/Faculty
   - A chat group with all the students and teachers of the same study year

2. Which messaging app platform do you use to communicate with your peers or students?
   - WhatsApp
   - Telegram
   - LinkedIn
   - Twitter messages
   - Discord
   - Slack
   - Snapchat
   - The platform provided by your own institution
   - None, I do not use any messaging app to communicate with my students

3. Which kind of chatbots (software that automatically respond to questions or commands) could be useful to improve the learning results with your students or help you managing your course?
   - Agenda bots that e.g. remind students about project deadlines
   - Bots that collect and provide answers to frequent questions
   - Bots that inform students about their grades
   - Bots that help with the class materials (e.g. searching for topics about a concept, or asking about them)

4. The virtualization of teaching due to the COVID pandemic during this year and the previous one, did it mean any change in your viewpoint or use of messaging apps in class?
   - No, I did not use any messaging platform before or now
   - Yes, I did not use any messaging platform before but I do use it now
   - No, I did not use any messaging platform before or now

The second survey, shown in its original form in Figure 19, followed the same paths, only in this case there was a single questionnaire, and with a different scope, focusing on the kind of interaction media features that teachers value the most. It was filled by teachers that were also students in a Professional Development course (on the use of new technologies in higher education, around 1/4 of them) as well as University of Granada teachers who knew about it by emails from the authors, or from the vicedeanship for International Relations that included it in its newsletter. This means that there might be a higher proportion of 1) teachers with few years of experience 2) teachers from the computer science faculty and 3) teachers from Granada. We think, however that there’s no explicit bias in this selection, although of course specific percentages will vary.

Specifically, this survey asked the teachers, in addition to general information (such as gender, age, experience, etc), what are their past experiences and needs with regard to the use of instant messaging applications with students, and even using bots or chatbots in the classroom. In addition the survey asked about the most relevant interaction media features for the teachers with respect to the potential tool to use in class.

The specific questions included in this second survey are listed below:

1. You prefer the interaction with your students to be ...
   - Synchronous: students and teacher/s in the same space, simultaneously. [Synchrony = Yes]
   - Asynchronous: the student asks at anytime, the teacher responds whenever possible. [Synchrony = No]

2. Regarding the interaction with your students, you ...
   - Prefer it to be done by institutional means/tools: office hours, forum/messages via the virtual campus, institutional email [Officiality = Yes]
   - Admit the use of other means/tools: blogs, chat groups in messaging platforms, any others. [Officiality = No]

3. Which media features do you value the most for your interaction with your students?
   - Familiarity with its use i.e. that I do not need to learn a new tool. [Familiarity]
Figura 18. Captura de pantalla del formulario de encuesta en español utilizado para la primera encuesta.

Sobre el uso de los sistemas de mensajería en clase, prefiere *
- Un grupo con los estudiantes de mi asignatura
- Preferir que los estudiantes se autoorganicen y no estar en ningún grupo de mensajería
- Un grupo para toda la titulación, Facultad o Escuela (profesores y estudiantes)
- Un grupo para el curso completo (profesores y estudiantes)

¿Qué plataforma de mensajería GRUPAL usas normalmente para comunicarte con tus compañeros y estudiantes?
- Whatsapp
- Telegram
- Linkedin
- Twitter mensajes
- Discord
- Slack
- Snapchat
- PRADO/SWAD/otra plataforma de aprendizaje específica de la universidad, titulación o departamento
- Ninguna, prefiero no usar ningún tipo de mensajería con los estudiantes.
- Otra...

¿Qué tipo de bots (programas que responden automáticamente a preguntas u órdenes) podrían resultar útiles para mejorar los resultados de aprendizaje de los estudiantes o ayudarte, en general, a gestionar una asignatura?
- Bots-agenda (que avisen p.e. del tiempo que queda para una entrega)
- Bots que guarden y recuperen preguntas frecuentes
- Bots que comuniquen las notas
- Bots que te ayuden con el material de clase (por ejemplo, haciendo búsquedas o preguntando)
- Otra...

La virtualización de la enseñanza debido al COVID este año o el anterior, ¿ha significado algún cambio en tu percepción o uso de mensajería en clase?
- No, antes la usaba y ahora la sigo usando.
- Sí, he cambiado de plataforma de mensajería a otras más seguras.
- Sí, antes no usaba ningún tipo de plataforma de mensajería y ahora sí la uso.
- No, no la usaba antes ni ahora.
- Otra...
**Figure 19** Screen capture of the Spanish-language form used for the second survey

| Pregunta                                                         | Opciones                                                                 |
|-----------------------------------------------------------------|--------------------------------------------------------------------------|
| Prefiere la interacción con el estudiante *                     |                                                                           |
|                                                               | Síncrona: estudiantes(s) y profesor(es) en el mismo espacio, simultáneamente. |
|                                                               | Asíncrona: el estudiante puede preguntar en cualquier momento, el profesorado contesta cuando puede. |
| La interacción con el estudiante prefiere que se lleve a cabo * |                                                                           |
|                                                               | Por medios "oficiales": visitas al despacho, foros/mensajes en el campus virtual, correo electrónico "corporativo" |
|                                                               | Admite el uso de medios "extraoficiales": blogs, grupos en programas de mensajería, otros medios |
| ¿Qué características valora en los medios Informáticos de interacción con el estudiante? |                                                                           |
|                                                               | La familiaridad con su uso, es decir, que no tenga que aprender nuevos medios. |
|                                                               | La formación que se haya dado sobre el mismo de forma oficial.             |
|                                                               | Que permitan la transmisión unidireccional, de profesorado a estudiantes |
|                                                               | Que no sean jerárquicos y que permitan la interacción entre profesorado/estudiantes y entre ellos también. |
|                                                               | Que permitan funcionalidades adicionales, como conexión a otras herramientas |
|                                                               | Que tengan un sistema que permita al profesorado añadir sus propias herramientas (por ejemplo, herramientas de corrección automática) |
|                                                               | Que me permita ocultar mis datos personales (tales como el teléfono) |
|                                                               | Que no me tenga que preocupar del mantenimiento y que sea fácilmente sostenible de un año al siguiente. |
|                                                               | Que me permitan extraer datos para evaluar el desempeño del estudiante |
|                                                               | Otro:                                                                    |

* Figure 19 Screen capture of the Spanish-language form used for the second survey
• The official formation/training provided by your institution on its use. [Official formation]
• That only one-directional communication is allowed (from teachers to students). [Unidirectionality]
• Non-hierarchical tools that allowed teacher-to-student and student-to-student communication. [Horizontally]
• Connectivity to other tools, for instance common login. [Connectivity]
• Possibility for teachers to develop/add their own functionalities (e.g. automatic correction tools). [Pluggability]
• Possibility for users to hide personal data (such as my telephone number). [Hidden Phone Number]
• Not having to worry about maintenance and that it is easily sustainable from one year to the next. [Sustainability]
• That it offers the chance to extract data to assess the student performance. [Analytics]