Politecnico di Torino

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Analysis of students' perspective about distance learning during the COVID-19 pandemic

Italian universities case study

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Contents

Introduction

The purpose of this thesis work is to try to better understand what Italian students' thoughts are about the distance learning that was conducted during the Covid-19 pandemic.

The aim is to analyze the experiences to detect the positive and negative aspects that were found by the students.

Specifically, the focus of the paper is on the following three macro-aspects:

i. The major differences from the pre-pandemic situation;

ii. The most effective teaching methods for students;

iii. The types of online exams that allow for results that are not distorted by the possible copying methods that can be implemented by students during online sessions.

The goal is to give insights to academics who are intent on using distance learning as a hybrid method during the period that is being experienced in the current days: the post-pandemic.

As we know, the pandemic has brought about a revolution in everyone's habits, obviously also in the lives of college students. The following chapters will investigate to understand which of the salient aspects of distance learning have proven successful and thus can be considered for the post-pandemic future.

The thesis is developed starting with the general context of what Covid-19 has disrupted in every person's life. The first chapter is in fact a description of what happened in the world and in Italy following the outbreak of the pandemic. This is followed, again in the first chapter, by a description of how Italian universities tried to cope with the huge and onerous problem. The specific case of one university was also reported: the Politecnico di Torino. Moreover, the first chapter contains a list and description of the main alternative teaching methodologies that have been most experimented with in Italy. Clearly, these types of alternative teaching did not originate contextually with Covid-19, however, they are teaching methods that also had to be reconverted to adapt to the pandemic situation.

To understand what Italian students think about the distance education conducted during the pandemic, the writer made use of a survey that she distributed to 331 Italian students. The survey has been distributed via various social networks, in the specific: Telegram, WhatsApp, Facebook. The purpose was to collect students sentiment about distance learning. The questions asked within the questionnaire are aimed at exploring the three macro-aspects listed above to find answers to better understand what Italian students think about distance education faced during the pandemic period. The structure of the survey was explained in detail within Chapter 2.

Chapter 3, on the other hand, contains the responses that Italian students gave to the questionnaire. This chapter serves to provide a general overview of what were the main trends in the responses; moreover, it served as the basis used for developing the hypotheses formulated and tested by the author in the further course of the paper.

The writer, after collecting the data in chapter 3, began the process of analysis.

Chapter 4 explains the adopted analysis methodology to provide the reader with a clear explanation of what are the statistical tests used in the following chapter. The questions posed to students were of two types:

i. Likert scales
ii. Purely qualitative questions

The tests used to analyze the answers were the following:

- T-test
- ANOVA
- Chi-squares for homogeneity
- Barlett's test
- Bonferroni post-hoc test

An engineering approach was adopted in the use of these tests, as pragmatism was preferred to theoretical purism. In fact, although all these tests refer to cardinal scales, it has been shown that, while not a perfectly rigorous approach, they are considered robust and effective even for ordinal scales, not affecting the outcomes obtained as a result.

To be sure of having a meaningful result, where possible, some tests of proportions were also conducted, which, although they provide a qualitatively lower result than the above tests, are a valuable aid in further confirming them since they are rigorous for the type of data analyzed.

The chapter 5, on the other hand, is that of proper analysis. Specifically, hypotheses were formulated by the writer for each salient part of the questionnaire, and then statistical tests (different from time to time depending on the type of responses to be analyzed and on the number of samples examined at the same time) were carried out to reject or accept the initial hypothesis.

Hypotheses were made by dividing the responses according to the category analyzed. By category we precisely mean the method of dividing the responses received into clusters. Specifically, the categories used to formulate the hypotheses in Chapter 5 are:

- **FIXED** categories

    - Geographical category: Students those studies in universities located in the North of Italy – Students those studies in universities located in the Center of Italy - Students those studies in universities located in the South of Italy

- University Path category: Students from Scientific universities – Students from Humanistic universities
- University size category: Students from small (<15k students) - Medium (between 15k and 24.5k students) - Large (>40k students) universities

- **MOBILE** categories
  - Total category: Division of the collected responses according to what is needed to be analyzed at that time

The responses to the questions were divided among the various sections within the categories to clusters the respondents as much as possible. The purpose is to try to find similarities or differences within the various categories rejecting or accepting the initial hypotheses about the distance learning methods used during the COVID-19 pandemic.

Chapter 1

The pandemic and the effects on university teaching

1.1.The Covid-19 outbreak

Who would have ever expected that in 2020, regardless of the great knowledge that human beings have gained in the medical, scientific and technological fields, humanity would have been surprised and put to the test by a virus?

No one would have imagined that in China, from within one of the country's largest markets, the Wuhan market, something would come out that would radically change the entire world.

At some point, however, everything changed. From today to tomorrow. In a way that no one would have ever expected. Mankind was precipitously hit by a major concern: a virus, THE virus, the coronavirus, Covid-19.

It is something invisible, but so powerful and lethal that it was able to put the world in serious trouble.

It soon became clear that this virus was very powerful, very aggressive, and most importantly, very contagious. Even though, initially, it was common thought that coming from very far away, Covid-19 would not affect our lives at all, the lives of us Westerners, Europeans, Italians. People just commented with astonishment, but also with a certain indifference, the news coming from China that spoke of how this new virus was deeply affecting the population forcing the major Chinese cities to isolate themselves to stop the spread of infection. It was as if the news did not really concern us that much. At that time covid-19 was considered only "a Chinese disease", nothing more.

Soon, however, the first cases began to be discovered in Italy and in the rest of the world, and from here on everything took a different turn.

Most countries have decided to close, for longer or shorter periods, offices, museums, sports fields, gyms, swimming pools, discos, places of religions, theaters, cinemas, schools and universities. Some countries around the world have tried to follow very restrictive lines, while others have pursued softer approaches to managing the emergency.

Humanity learned in a very few weeks to live a completely different life from the one it had always lived. Every company, every meeting point, every space that had the purpose of bringing people together found itself with its doors locked. People had to learn to do business in a different way, in an innovative way, in a remote way.

Every person's life abruptly changed.

People had to keep doing the things they always did, but they had to do them differently: All people had to stay isolated.

From that point on, humanity was faced with an emergency, an unprecedented emergency, which soon turned into a worldwide pandemic in 11th of March 2020. No one could have foreseen it, no one had ever imagined that one day we would find ourselves all locked in our houses, with the obligation not to go out and with a virus outside the doors able to replicate itself to the unbelievable and, above all, able to reap many, many victims.

But the main concern was that no one knew how long this situation would last.

1.1.1. The pandemic in Italy

Italy was one of the very first countries (together with Iran and South Corea) in the world to record the first contagions and the first victims outside China. At the beginning of this situation, however, it seemed that everything would be resolved in a few days, without any consequences. Initially, people were convinced that the much talked about Covid-19 was in fact "little more than a trivial flu", nothing to worry too much about. They protected themselves thinking that everything would probably be over soon anyway.

Initially, the Italian government, of which the lawyer Giuseppe Conte was the President of the Council of Ministers, assumed that the problem in Italy would be solved by indicating the lockdown only in the countries of Northern Italy where the first cases were recorded. It happened on 21st of February 2020. Needless to say, that in reality this theory was a failure because the infections began to grow day by day with an exponential trend, soon after the situation precipitated.

On March 4, the government decided to close schools and universities and the recommendation to implement smart working where possible throughout Italy until March 15. It was supposed to be a short period in which everything would be resolved so that we could continue to live our lives exactly as we were used to doing until a few weeks before. So, it was not, because Sunday, March 8, Lombardy became a red zone, an area where it was possible to leave the house only for proven reasons of necessity such as grocery shopping, work needs, the purchase of drugs or other health reasons.

Realizing that the situation was becoming unbearable also in the rest of Italy, on Monday March 9 Giuseppe Conte announced on television to have extended to the whole country the measures taken the day before for Lombardy.

It was necessary to make sure that covid-19 stopped circulating. Avoid the possibility of reproduction of the virus became a priority and the only way was to make people stop meeting; therefore, it was necessary to close every place that could lead them to see each other.

Everyone had to stay indoors and avoid contact with other people. Social distancing had become the first rule. No more dinners with friends, no more praying in church or other

places of religion, no more shows, no more lectures, no more congresses, no more conferences, no more teachers speaking in front of classes full of students.

Shortly after, yet another step was taken: every productive activity that was not strictly necessary, crucial, indispensable to guarantee essential goods and services was closed throughout the country. It was March 21, 2020.

From this point on, the idea that the pandemic would disappear shortly thereafter began to fade in the minds of Italians, perhaps this emergency was different from all the others faced up to now. Unfortunately, so it was, as covid-19 continued to claim victims and fill hospitals for many months, bringing us into long lockdowns and progressive restrictions that were (and still are, at the time of writing this manuscript) dictated by the number of daily infections and the remaining places in intensive care units.

We had to learn to live differently: workers in non-essential services no longer had to travel to their place of work, but instead turned on a computer and worked by collaborating with colleagues via videoconferencing. So it was that living rooms, kitchens and bedrooms all over Italy became real offices.

Gyms began to offer online courses; going out with friends turned into group video calls. Restaurants had home delivery as their only source of income; it was possible to do shopping exclusively online. Students of all ages stopped crowding the public transportation that often took them to school or college and began taking classes through distance learning.

Speaking of students, the purpose of this thesis will be to analyze how in Italy, because of the pandemic, has changed the way to live the university, how to make lessons and exams.

The objective is therefore to try to go into detail about the methods used to overcome the problems imposed by the pandemic and social distancing, trying to understand if there are similarities between the methods proposed by the various Italian universities.

In addition, the thesis has the purpose of trying to understand which methods are actually effective and how much of what was developed during the emergency the university environment will try to integrate into the routines of what will be the new post-pandemic normality.

1.2.The remote teaching in Italian universities

Universities, since time immemorial, have always conducted their activities in a very traditional way. Italy has always been an extremely conservative country in training professionals. In fact, most universities have always seen the professors behind the desks with hundreds of students listening as the only way to teach and build the cultural background of practitioners.

Students were required to attend courses and attend exams in presence and after that they used to gather in study groups, in the crowded libraries and in the canteens. With courses, afternoon seminars, conferences and departmental receptions, attending classes in person has always been a real moment of aggregation. Every student, every teacher and all the "insiders" have always taken for granted that this was normal and probably, for many, it was the only possible way to live the university. Changes have always been very slow and never sudden, everything has always been done in a classic, time-tested way, no external event has ever managed to disrupt what have always been the routines and ways of operating in universities.

All of a sudden, things changed.

The government, due to the number of Covid-19 infections that had become really worrying, decided to temporarily close schools and universities, as they were very popular places, and it would have been impossible to limit the contagions inside. As illustrated in the previous paragraph, it was initially thought that a brief closure would be enough to stem the contagions and resume normal life.

No one had ever experienced such a situation: a closure of school and university buildings due to a virus. There was a lot of uncertainty, and the thing that created the most instability was knowing that in reality no one could give certain answers about how the situation would evolve.

The universities (as well as all sectors of the country) have, therefore, immediately had to start dealing with total uncertainty about the date of reopening. Therefore, each Italian university had to roll up its sleeves to figure out how to continue conducting its activities despite the emergency.

They were facing the greatest challenge ever: having to continue training students without being able to use, from one day to the next, the fulcrum, the backbone of their work: the physical locations of the universities.

There was an initial and brief period of adjustment in which almost all Italian universities had to think about what to do, and in which they were forced to interrupt the services they provide to prepare for a radical, epochal change. In fact, it must be said that there has been a huge step forward, a real boost, towards digital.

In a very short time, ways had to be found to continue to carry out lessons (even the most complicated ones to be done remotely, i.e., technical labs), and exams.

The next paragraph will explain in detail how one of the most important universities in Italy, il Politecnico di Torino, has organized itself to face the pandemic.

1.2.1. Example case: il Politecnico di Torino

Il Politecnico di Torino has moved from the beginning to operate in full compliance with the ministerial decrees that followed as the emergency continued.

The Rector, Professor Guido Saracco, kept colleagues and students informed on the developments of the emergency through videos and emails. All communications from the Rector were immediately collected on the webpage dedicated to the Covid-19 emergency[1].

In the first period it was necessary for the polytechnic of Turin to suspend exams and lectures, as a new organization was needed to cope with the emergency.

On March 1, the entire community of Politecnico di Torino was informed that the entire second semester of the 2019/2020 academic year would be delivered in telematic mode, because:

- 1200 students enrolled at the University were residents of the regions or provinces or municipalities listed in Annexes 1, 2 and 3 of the DCPM of 1/3/2020;
- many foreign students, when the epidemic broke out, returned to their countries of origin also following the recommendations of their Embassies and in some cases cannot, even willingly, return to Italy due to flight restrictions;
- many Italian students have returned to their regions of origin and the Minister of University and Research has recommended to all the Rectors of the Universities whose teaching activities have been suspended to progressively adjust this measure in a transitional period before rescheduling all the teaching activities in the University's seats and classrooms; this has been recommended in order to avoid mass displacements of students between Italian regions.[2]

The day March 9, 2020 was a very important day, as the lessons of the second semester of the academic year 2019/2020 started, completely online.

As a rule, excluding exceptional cases that has been dealt with specifically, it was necessary to use the Big-Blue-Button software made available on the teaching portal of each professor and student for remote teaching.[3]

At the end of the first day of online lectures some connectivity issues occurred. The Politecnico's servers were put to the test as it was the first time that such a large number of students were connected at the same time.

All in all, however, the balance was positive, but to overcome the problems encountered, the rector strongly advised teachers to organize their lessons in the following way:

[1] https://www.coronavirus.polito.it/en/measures_adopted_by_the_university
[2] Polito Rector's email sent to students and professors on March the 1st 2020
[3] Polito Rector's email sent to students and professors on March the 3rd 2020

1) for the courses hosting more than 150 students:
    a) The use of the available prerecorded lectures was highly recommended. They should be uploaded in the teaching portal. The students had to follow these lectures on their own. Slots in the agenda of the normal course schedule was supposed to be used by the lecturer to reply to the questions asked by the students via email.
    b) Pre-recording of lectures via software like Power-point, OBS, Noteability, etc. was recommended as an alternative. These recorded lessons had to be uploaded in the Teaching Portal and then a Q&A session with students must be planned as for point 1 above.
2) For the courses with less than 150 students:
    a) Professors had to keep on using BBB (Big Blue Button). The professor's camera was supposed to be used exclusively for the amount strictly required and clear from time to time the chat.
    b) In case the professor was proficient with one of these tools, you may also select a different software that does not overload Politecnico's servers: e.g., Zoom, Skype, etc.[4]

Suddenly, the pandemic situation in Italy and in the rest of the world was every day more difficult. The 10th of March, the government issued a decret in which was written that every Italian schools and universities had to continue with virtual lectures until the 3rd of April 2020.

That were extremely difficult days because the online activities had to be carried on also in the long term. To overcome this issue and to increase the online lectures quality, the Politecnico di Torino gave the possibility to professors to teach from the main Politecnico's buildings: The central building and the Castello del Valentino.

In few days the Politecnico's decision was to do the entire semester in remote teaching since the virus was spreading even if almost the entire world was in lockdown.

Subsequently, the Politecnico decided to also deliver the entire 2020-2021 academic year in remote mode, reserving the option, at times when the Piedmont pandemic situation permitted, to deliver some lectures both in-person and in remote mode

During the whole emergency, il Politecnico di Torino has put itself and is putting itself in the front line to carry out initiatives that could benefit not only the Politecnico community but also the entire population. Here are the main initiatives that have been put in place to cope with the fight against covid-19:

[4] Polito Rector's email sent to students and professors on March the 9th 2020

- **PolyTOtracing**

  It consists in rapid swab screening to detect prevent early outbreaks and improve tracking of Covid-19 contacts in the University. The University starting from the academic year 2021-2022 is committing to perform a considerable number of rapid swabs every week, free of charge and directly at the University, to a random selection of people who join the campaign, in order to enhance the contact tracing activities of Covid-19 cases in the University.

- **The Polytechnic for the vaccine**

  The Politecnico and the University of Turin offer the opportunity for students to undergo vaccination at the Vaccination Point of the Rectorate in Turin.

- **“Open companies, protected workers" project**

  "Everyone protects everyone": this is the slogan of the initiative that has been taken in place during the so-called Phase 2, that of the reopening of production activities.

  A group of technical and scientific experts from Piedmontese universities and other universities and research centers, coordinated by the Politecnico di Torino, has developed a series of guidelines to be delivered to policy makers to restart the country in safety, collected in the report "Imprese Aperte, Lavoratori Protetti" and in a series of thematic reports, dedicated to specific areas such as schools and sports.

- **#POLITODATE**

  An innovative way to open up to all citizens at a time when it was not possible to physically access the Politecnico, sharing resources and making scientific, cultural or entertainment content available to all. In this way, the Politecnico enters via social network at the home of all those who have an interest in the polytechnic culture and want to deepen more or less technological topics.

  Support for the certification of masks and personal protective equipment.

  Many companies in the Piedmont region have declared their willingness to produce personal protective equipment to combat the current epidemic, such as masks and gowns, which health workers constantly need and which are becoming increasingly difficult to find. The universities of Piedmont, together with the Region, have immediately taken steps to support this generous response from the business world by providing their expertise and laboratories to speed up the process of certification of the materials produced, so that they can be made available more quickly to health workers.[5]

[5] https://www.coronavirus.polito.it/iniziative

1.3.Main methods of remote teaching

The absence of physical interaction has obviously created quite a few problems from the point of view of learning, socialization and student involvement during lessons.

To overcome this, many willing and ambitious teachers have tried to adapt to alternative ways of teaching, continually seeking guidance and support on how best to organize their teaching proposals. Thus, they have tried (where possible) to avoid the simple "frontal" lessons in which the teacher is the focus of the lesson, the person who present new information through a lecture or presentation in front of the camera of his PC and the students listen from their own homes.

The reason why many teachers have tried to innovate and renew their way of teaching was not only to ensure adequate learning for students, but also (and above all) to try to recreate as much as possible the university environment, collaboration among students and sociality.

The primary strategies that exist for conducting lessons in innovative ways are:the following and will be illustrated in detail in the following paragraphs:

- The **flipped classroom**: a method that relies on students' pre-lesson preparation. Before addressing each curricular topic in the (virtual) classroom, the teacher makes available online videos and readings that students are required to view. In class, the teacher does not give frontal lessons but at most clarifies some doubts to individual students while the rest of the class is engaged, from the beginning to the end of the hour, in written-oral-practical activities;

- The **project work (or reality tasks)**: through this method the students themselves solve a situation-problem as close as possible to the real world, using knowledge and skills already acquired;

- **Challenge-Based Learning** (between groups or between individuals): They are designed to push students to reason and give the best of themselves through healthy competition among themselves.

- **Peer to peer learning**: it is aimed at enhancing students' individual skills and preventing socially negative behaviors;

- **Group work**: it is a method that tends to stimulate socialization by bringing students into many virtual classrooms in which they can work;

- **Gamification**: it is learning achieved through the use of games that can sometimes start as entertainment tools but are then used to reach an educational goal.

There are also many Apps offered by the web to put into practice these innovative models of teaching that guarantee sharing and collaboration among students and between them and teachers. We recall: Pear Deck, Nearpod, Kahoot (for quizzes), Google Modules, Questbase; Mentimeter (for real-time interactive activities); the platforms Phet Colorado,

WolphramAlfa (as simulation environments); GeoGebra (as dynamic geometry software); Learning Apps and Genially (for gamification). [6]

1.3.1. Flipped classroom

The flipped classroom uses the potential of new digital devices it breaks down the lesson into multiple moments, inside and outside the classroom

In order to ensure a thorough level of discussion, it is good to rely also on scientific texts such as, for example, those from the electronic libraries of the respective universities, from Google Scholar or from accessible parts of Google book.

In addition, the classic slides summarizing the course indicated by the teacher can remain available, enriched by what has been produced together with the students.

Finally, you can open discussion groups, with the participation of the teacher himself, whose function is obviously not only to answer questions on the subject, but in fact also to support students in their study and to unravel the doubts that may arise during the study of the teaching material.

"Flipped classroom" is basically a reversal of the traditional schooling method: what was done in the classroom and at home is turned upside down.

Obviously, each different objective may correspond to a different medium and environment to be used: the simple written text, multimedia, devices for content creation, etc.

The moments in which memory and understanding are constructed can therefore be anticipated with respect to the classroom lesson, in which application, analysis, evaluation and creation can already be practiced, actions that can be supported by the mobile devices available to students.[7]

1.3.2. Project work

The project work is a situation-problem, as close as possible to the real world, to be solved using knowledge and skills already acquired during the lectures, putting into practice problem-solving skills and different skills in relation to the activity within social contexts moderately different from those made familiar by teaching practice.

[6] http://orizzonteuniversita.it/dad-i-metodi-dinsegnamento-alternativi/
[7] https://www.agendadigitale.eu/scuola-digitale/capire-la-flipped-classroom-pro-e-contro/

The task is never just an individual "commitment", but can be carried out, in whole or in parts, individually, in pairs, in small groups and include moments of sharing with the whole class, in the large group, for the final argument (circle time).

To be effective, the task must have an evident and direct connection with the real world and an explicit significance for the students, who are stimulated and motivated by the challenges it proposes. The work commitment required must be located in the zone of proximal development of each individual, in which the situation is not yet "well known" but all the cognitive tools are available to deal with it and solve it. [8]

A university group project gives students the opportunity to learn how to work in teams and organize the division of tasks. It also gives the opportunity to meet new people, which is very rare during periods of social isolation, and to confront with them in order to achieve a single goal: the delivery of the final work. Moreover, a group project needs to solve problems within certain deadlines, thus helping students make decisions.

All these aspects allow the development of skills such as the ability to work in a team, the ability to problem solve, the ability to work by objectives and deadlines, all skills that are extremely useful in order to undertake any subsequent work activity.[9]

1.3.3. Challenge-Based Learning

Challenge-Based Learning (CBL) is an instructional approach through which students are proactively engaged to identify, analyze, and design a solution that would solve a challenge, i.e., a challenge on current issues and real-life topics.

CBL consists of three main phases:

1) Engagement, i.e., the commitment students make to addressing a challenge, defining the problem to be solved, and asking the right questions;
2) Investigate, which is the inquiry phase through which relevant information is found and analyzed;
3) Act, which is the phase of designing, implementing, and evaluating the solution.

Students get to apply their knowledge and skills to real-world problems and often learn to collaborate with colleagues from different disciplines in interdisciplinary teams.

Through the CBL you have the opportunity to deepen the subject of study through doing (learning by doing), and improve the so-called soft skills such as empathy, teamwork, stress management and time management, problem solving, interculturalism, communication skills.

[8] https://www.erickson.it/it/mondo-erickson/articoli/che-cos-e-un-compito-di-realta/
[9] https://tesinsieme.it/5-ottimi-motivi-per-partecipare-a-lavoro-di-gruppo/

But above all, challenges have the extraordinary advantage of enabling students to gain experience in the world of work even before they finish their studies.

Challenge Based Learning should not be confused with project work (or reality tasks). Unlike the latter, which is based on the analysis of case studies or the solution of a fictitious problem, CBL is aimed at finding a concrete solution to a current problem provided by a "challenge provider", i.e., a company or institution motivated to find a solution to a real issue.[10]

1.3.4. Peer to peer learning

Students does not learn from the teachers but they learn from other students, their peers in the course.

The Peer Education method implies, a bit like the Flipped Classroom, a clear change of perspective in the learning process, which will see the students, and not the teachers, at the center of the educational system. [11]

Peer education makes it possible to more effectively convey the teaching of life skills, essential skills for the achievement of educational success by each student.

it is possible to carry out peer to peer learning in many different ways, the main and most used are:

1) Research to be exposed to the whole course: students are divided into various groups, more or less large depending on the topics to be covered and the boundary conditions, after which a topic is assigned to each group to be treated and deepened. The research produced by the various groups will eventually be exposed, in turn, to the rest of the course.

   In this way, students who expound on the concept can practice their public speaking skills, but also their ability to work as a team and team up to achieve a common goal. In addition, they can for once put themselves in the shoes of the lecturers by becoming the presenters of the lesson themselves. On the other hand, the students who listen have the opportunity to take inspiration from the other students' exposition in order to improve themselves and create their own ways of oral exposition. In addition, they have a way to learn the explained topic from a different point of view, which is not that of the simple teacher.

   Last but not least, the students' exposition assimilates the concepts thanks both to the effort they have to put into researching the content to present to the entire course and to the next step, which is to find a way to present the topic as clearly as possible to the rest of the course.

[10] https://webmagazine.unitn.it/internazionale/92341/il-challenge-based-learning
[11] https://www.metodologiedidattiche.it/2017/12/09/peer-education/

Evaluation of the presentation can be assigned (at the discretion of the instructor) either by the students who attended the presentation, or by the instructor himself.

Evaluation assigned by students allows for even greater focus on the topic being presented, as in order to best evaluate, students engage in understanding what the exhibitors are illustrating to them.

2) Papers to be exchanged and peer-reviewed: the teacher creates groups and assigns each group a topic to develop and explore in a paper. At the end of the creation of all the papers, the various groups exchange their research and grade the others. In this way, each paper will be evaluated by other groups of students.

   Students therefore have the opportunity to learn from the work of others, but also to measure themselves with the evaluation of other students, something that in other teaching methods is always left to the professor.

1.3.5. Group work

The group works (or group exercises) are designed to make sure that each student has an active part during the course.

The teacher, after explaining the main features of the topic, divides the students into groups, creating as many virtual classrooms as there are groups. At this point, each student enters his or her own dedicated virtual classroom and performs exercises or studies together on the insights that the professor provides.

In this way, students have the opportunity to interact with a small group of people and often have the opportunity to meet new people with whom they can compare notes. Group work therefore gives students the opportunity to work collectively, training them to be in a team and carry out a single common goal: the task assigned by the professor.

The role of the professor remains fundamental to the success of group work, as it is necessary that he or she oversees the proper execution of it. The professor is needed to rotate between the various virtualclassrooms in order to understand if there are any doubts or perplexities of the students and at the same time guide them towards the correct execution of the exercise.

1.3.6. Gamification

Gamification implies the introduction of methods and techniques of game design in contexts different from those simply of game. In fact, it takes advantage of the connectivity of devices, the interactivity to which students are now accustomed, the principles underlying the concept of fun itself.

The characterizing part of gamification is the integration within the teaching of typical game logic to convey messages and induce active behavior by users, allowing to achieve specific goals, personal or team.

The integration of game elements is designed to make teaching more engaging for students, even with the inclusion of scores, competitive elements and so on.

Listed below are 5 simple features of gamification for DAD that are useful for inspiring students to perform better:

1) **Leaderboards**

   Leaderboards are one of the most distinctive gamification elements, as they stimulate a healthy sense of competitiveness among students, who tend to outperform their peers in order to achieve the coveted "first place".

2) **Scoring**

   Points are earned by completing activities suggested by the professor or by participating in voluntary online training sessions.

3) **Certifications**

   Certifications are the tangible attestation of performance. Students must meet their goals or showcase their skills to receive certification. A typical mechanism used is for multiple "minor" milestones to accumulate (e.g., if they successfully pass several tests or activities), they can receive a certification to keep track of their progress as well as to show the audience their achievements.

4) **Keys**

   Students must complete an online training activity or module to earn what is known as a "key". This "key" will unlock the next level or, by saving a certain number of keys, gain access to a reward.

Those described are some of the main techniques used in games and found to be very valuable when placed in training contexts. Obviously, the introduction of all or some of these elements may also depend on the number of students involved and the complexity and duration of the course in question. The goal of gamification is to find an approach that cultivates the right amount of competition and leverages the motivation that students, if properly stimulated, can develop.[12]

[12] https://www.federica.eu/gamification-ecco-5-caratteristiche-fondamentali-per-elearning/

Chapter 2

Distance learning, how are we dealing with it?

2.1.The students' point of view: the survey

During the pandemic there are efforts being made to ensure that, despite the difficulties and the emergency, everything continues to work as before. Obviously, this is not an easy challenge.

Universities, as well, are facing a huge challenge.

With this thesis, the writer wants to try to understand:

i. The major differences from the pre-pandemic situation, from the perspective of students
ii. The most effective teaching methods for students.
iii. The types of exams that allow for results that are not distorted by the possible copying methods that can be implemented by students during online sessions.

To do this, the writer made use of a customized survey to ask Italian students about their impressions of distance learning.

The survey was distributed through various groups of students belonging to different social networks. Specifically, it was shared on: Facebook, WhatsApp and Telegram.

Given that the perimeter of the research is students attending Italian universities, the survey has been written and distributed in Italian, in order to reach a better engagement from Italian students.

Responses were collected between January 31, 2022 and February 5, 2022. There was a total of 331 responses to the survey and they came from students all over Italy.

2.2.The survey structures

The survey that has been distributed consists of 4 macro-sections:

1) Introductory part
2) Main teaching methods (frontal teaching and alternative teaching methods)
3) Considerations on teaching
4) Exams carried out in remote mode

In the graph below (graph 1), to provide more clarity to the reader about the working mechanism of the survey, is shown schematically the process that is followed depending on the answers that the student gives.

The use of this chart will make the following paragraphs easier to read. The writer included within the graph all the key points of the survey that determine a change in the compilation depending on the answers that the student selects.

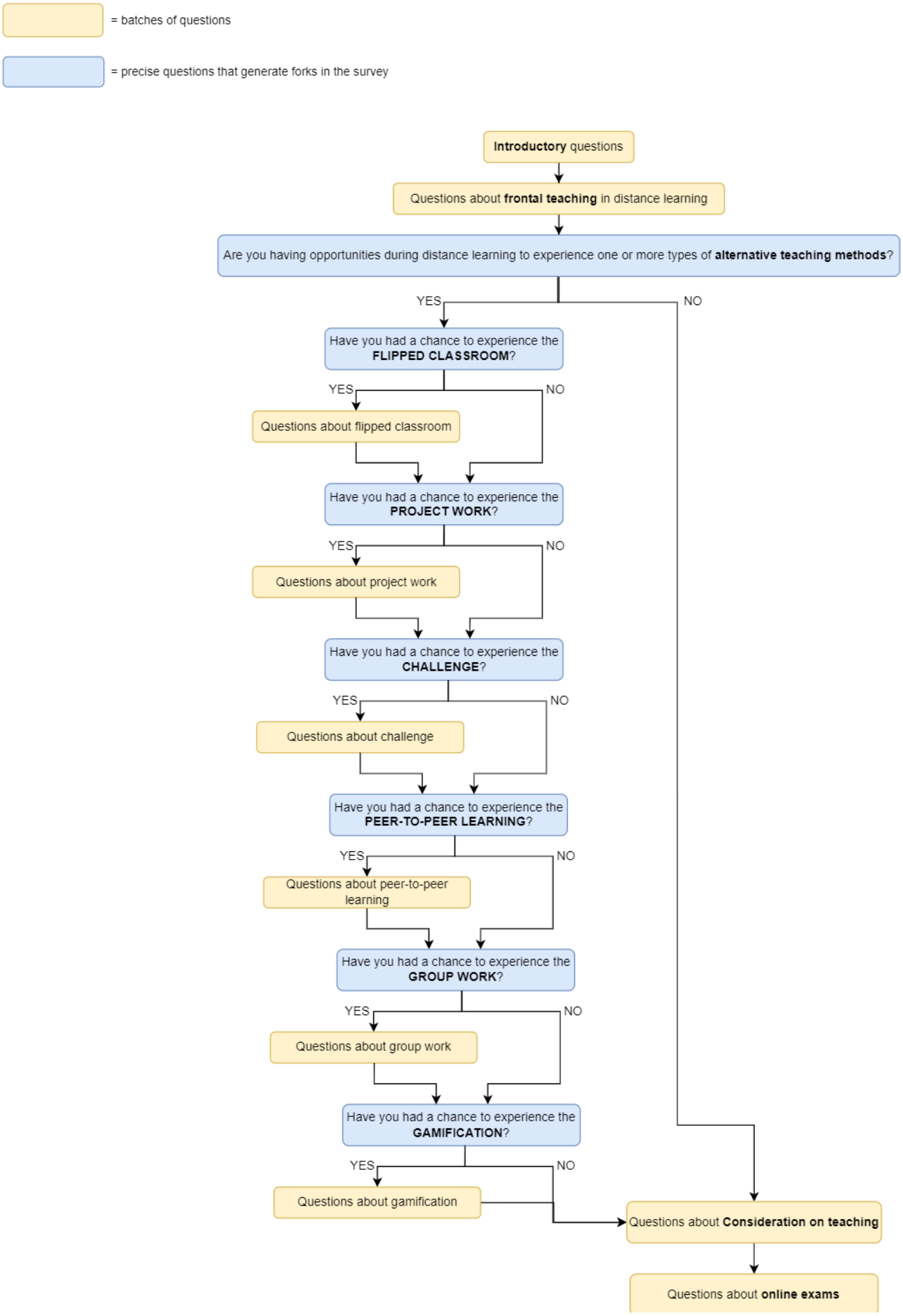


Figure 1 - survey flowchart

2.2.1. Introductory questions

As an introduction to the entire survey, a description was placed to encourage students to provide their answers and, above all, to describe why the questionnaire was created.
The description is as follows:

"Hi there!

I'm Sofia, a graduate student in Engineering and Management at the Polytechnic of Turin.

Yes, mine is the umpteenth request to fill out a survey, please bear with me, it is the only way I have to collect information that can help me make considerations about how we students have lived/are living the distance learning.

What I am simply asking is a couple of minutes of your time and complete honesty.

Be advised, there will be some UNCOMfortable QUESTIONS, especially in the final part (of course it's anonymous ;))

Let me know yours!"

Following the introduction, the survey kicks off with the actual questions. The questions in the first section are aimed at locating the student and gathering his or her first idea about distance education.

The main purpose of questions 1 through 3 is to understand where the student is studying, what degree path they are following and what software he commonly uses for online lectures.

1) *What degree path do you attend?*
   - *Bachelor - humanistic area*
   - *Bachelor – scientific area*
   - *Master - humanistic area*
   - *Master – scientific area*

2) *What university do you attend?*
   - *Here a drop-down menu with all the Italian universities is provided*

3) *During distance learning, what software are/was used to lecture?*
   - *Zoom*
   - *Microsoft Teams*
   - *BBB (Big Blue Button)*
   - *Google Meets*
   - *Skype*
   - *Other*

In addition, some questions (4 through 6) were included to understand if the student has the right tools to be able to take classes and exams in distance learning.

4) *Do you feel that the PC you have is suitable for taking lectures?*
   - *Yes*
   - *More yes than no*
   - *More no than yes*
   - *No*

5) *Do you feel that the internet connection you have is suitable for taking lectures?*
   - *Yes*
   - *More yes than no*
   - *More no than yes*
   - *No*

6) *Do you feel that the study station (chair, desk, or any other support) you have is suitable for taking lectures?*
   - *Yes*
   - *More yes than no*
   - *More no than yes*
   - *No*

The questions from 7 to 10 are the first to get to the heart of the topic of distance learning, as they ask the student what his impressions about the topic are, how he has benefited and if he has found improvements compared to pre-pandemic teaching.

7) *What do you think is the greatest strength of distance learning?*
   - *Saving time spent traveling (e.g., home-university commute)*
   - *Flexibility in the use of video-recorded lessons*
   - *The possibility of staying home on days when it would have been more complicated to get to the university (ex: weather conditions)*
   - *Take advantage of certain educational programs without incurring the costs of a non-resident student*
   - *Other*

8) *What do you think is the biggest weakness of distance learning?*
   - *The greater ease in getting distracted and losing focus during class*
   - *Losing the college routine I had created*
   - *The fact that my relationship with my colleagues has changed: I have felt more alone*
   - *The decreased motivation to study and strive to do my best*
   - *Lower quality of teaching*

9) *After taking classes in distance learning, I feel less ready for exams than when I took in-person (pre-pandemic)*
   1 – NOT agree at all
   4 – Extremely agree

10) *By taking the courses in distance learning I am able to keep up with the lessons of the courses more than when I was taking in-person (pre-pandemic)*
    1 – NOT agree at all
    4 – Extremely agree

At this point, a short, informal text was introduced to keep students' attention:

"In the next section, you will be asked questions related to the teaching methods you experienced during DAD. Click Next to increase my chances of graduating. Thank you :)"

2.2.2. Main teaching methods (frontal teaching and alternative methods)

The second macro-section of questions is definitely the most extensive and the one that may take the most time to complete.

The purpose of this section is to collect data on the online teaching methods that students experienced during the pandemic.

The teaching methods investigated in this section are the main teaching methods described in detail in Chapter 1 of this thesis, that are:

1) Frontal teaching
2) Flipped classroom
3) Project work
4) Challenge
5) Peer to peer learning
6) Group work
7) Gamification

In order to prevent students from not immediately understanding what the names of the various types of teaching actually referred to, a brief description of each type of didactics was included before being treated specifically through the questions.

2.2.2.1. Frontal teaching

The first block of questions concerns frontal teaching. Specifically, the supporting description is as follows:

"Frontal teaching (or vertical teaching) is nothing other than traditional teaching: the professor explains to the students the topics of the course (sometimes with the help of slides) and the students just listen and at most ask a few questions if necessary"

The first questions about frontal teaching concern students' perception of it. In fact, students are asked to quantify how involved they feel during online lectures in frontal teaching mode, how much they manage to assimilate in relation to pre-pandemic frontal lectures, and whether they evaluate online teaching in frontal mode as an efficient way to lecture. Specifically, the questions are:

1) *During frontal lectures in distance learning, I often feel poorly involved*
   1 – NOT agree at all
   4 – Extremely agree

   Lectures using the frontal teaching approach are a good way to approach distance learning
   1 – NOT agree at all
   4 – Extremely agree

2) *During the lessons in distance learning with frontal modality I assimilate better the concepts in comparison to when I attended the lessons with the same approach in presence (pre-pandemic)*
   1 – NOT agree at all
   4 – Extremely agree

At this point in the survey, the last two questions about frontal teaching address the major advantages and disadvantages that students perceive in frontal teaching in a remote mode. Specifically, the two questions are:

3) *What do you think is the greatest advantage of distance learning conducted through frontal teaching?*
- *Similarities of the course in distance learning with the course taken in attendance (e.g., I can use notes from past years)*
- *Not having to actively participate*
- *Flexibility in choosing when to study*
- *Other*

4) *What do you think is the worst disadvantage of distance learning conducted through frontal teaching?*
- *The sense of loneliness that one can often feel*
- *The completely passive participation of the students*
- *Lessons are not very innovative and often boring*
- *Other*

2.2.2.2. Alternative teaching methods

The following question has a quite long introduction. It is important to highlight that this is a key question, as it allows the student filling out the questionnaire to cross a "fork in the road." Please refer to the graph 1 to better understand.

The introduction to the question is:

"*Alternative teaching refers to all types of teaching in which student involvement is required. For example, they can be:*

- *Flipped classroom*

- *Group projects or activities*
- *Research to be exposed to the whole course*
- *Grouping students into small teams to do exercises*
- *Peer to peer learning*
- *Challenges taken directly from the real world of work"*

Whereas the question is:

1) Are you having opportunities during distance learning to experience one or more types of alternative teaching implemented by your professors?

- *Yes*
- *No*

As understood, the above question allows to know if the student has had the opportunity to try out distance learning courses that used (in whole or in part) alternative teaching.

The continuation of the survey depends on which answer the student selects in this question:

- If the student selects "Yes," the survey directs the student to a series of questions regarding the alternative teaching methods mentioned in Chapter 1. These questions will be discussed in detail below;
- If the student selects "No," all questions about alternative teaching will be skipped. Subsequent questions asked to the student will be about "Consideration on teaching".

At this point, please assume the student has selected "Yes" to the previous question.

From now on, a series of questions will appear for each type of alternative teaching method. The structure and the questions will always be the same for each batch of alternative teaching method (flipped classroom project work, challenges, group work, peer-to-peer learning, gamification).

The structure is composed by:

i. Description of the type of alternative teaching method involved;
ii. Question about whether the student has tried the type of alternative teaching involved;
    - If "Yes" is selected, the student is asked a series of questions aimed at better understanding his considerations about that type of alternative teaching.
    - If "No" is selected, the survey will go directly to the question about whether the student has tried the next alternative teaching method proposed. Therefore, the survey will not show all the questions regarding the alternative teaching methods that the student states he never had the chance to try during the pandemic.

2.2.2.2.1. Description of alternative teaching methods in the survey

Therefore, it is useful below to list the descriptions that were included within the survey as an introduction to each alternative teaching method.

Regarding the ***flipped classroom***, the description used is as follows:

"In the flipped classroom method, students are required to view material that the teacher provides them with regarding a specific topic.
The classroom hours are used to do exercises, to establish moments of discussion and comparison and to clarify any doubts."

Instead for **project work**:

"Project works are defined as doing a problem that is very similar to reality.
Projects are carried out in groups of students, which, depending on the tasks to be performed, can further divide into subgroups.
The main feature of group projects is the fact that students are asked to solve a situation-problem that is as similar as possible to something that can happen in reality, using knowledge and skills acquired during the course"

Regarding **challenges**:

"Challenges are nothing more than real problems that real companies pose to classes of students, who divided into groups will try to find the best solution for the company or institution that has placed them the challenge.

Warning*!!! The main difference between the projects of group and the challenge is that the first are simulations of reality, while the second are real cases to solve which always have a client"*

Peer-to-peer learning has been introduced as follows:

"In Peer-to-Peer learning, students teach other students in a mutual exchange of knowledge.
The teacher divides the course participants into groups, assigning each group a topic to study and deepen.
In turn, each group will be responsible for exposing to the rest of the course what they have learned and deepened.

Another type of peer-to-peer learning is the production of research by small groups or individuals. The various papers are then read and evaluated by other peers, who, having to commit to giving a grade, study the topic set forth by their peers"

The **group work** description is:

"By group work we mean all those strategies that teachers adopt to make students work with each other: students meet in virtual rooms in small groups so that each person can give their contribution to the achievement of the objective.

During group exercises, the most common tasks assigned to students are:
-The resolution of some exercises by reasoning all together;
-Collective study of a specific topic"

In the end, **gamification** introduction is:

"By gamification is meant the inclusion within the educational activities of elements typical of the game, for example:

-Classifications among students (or groups of students) based on points acquired in various learning activities
-Objectives to be reached in order to go further and further along the learning path"

2.2.2.2.2. Questions asked for alternative teaching methods

In this paragraph the questions that are asked for each type of alternative teaching are analyzed.

For the sake of simplicity, we are going to analyze the questions related to the flipped classroom, keeping in mind, however, that both the questions and the mechanism by which they are shown are the same for each batch (flipped classroom project work, challenges, group work, peer-to-peer learning, gamification).

The first question about flipped classroom is also the one that will allow the survey to show to the student the other questions about flipped classroom. It is the following:

1) *Have you had a chance to experience the flipped classroom?*
   - *Yes*
   - *No*

- If the student selects "Yes" to this question, the following questions related to the flipped classroom are also asked. They are the following:

2) *What college courses have you had the opportunity to try the flipped classroom in?*
   Open answer

3) *I think the flipped classroom mode helps make us students feel more involved, thus allowing us to be an active part of the lesson*
   1 – NOT agree at all
   4 – Extremely agree

4) *I believe that the flipped classroom is an effective way to best learn the concepts of many college courses in distance learning*
   1 – NOT agree at all
   4 – Extremely agree

5) *During the lessons in distance learning with "flipped classroom" mode I quickly assimilate the concepts*
   1 – NOT agree at all
   4 – Extremely agree

6) *I believe the flipped classroom method helps reduce the physical distance with colleagues and professors*
   1 – NOT agree at all
   4 – Extremely agree

7) *Do you think the flipped classroom could be a viable alternative method that could also be used in what will be post-pandemic?*
   - *Yes*
   - *No*
   - *Other*

- If the student selects “No” the survey goes directly to the section related to “Project work”, skipping all the question related to flipped classroom.

As said before, the question from 1 to 7 will be the same for each alternative teaching method. In this way it will be possible, in the next chapter of this thesis, to better compare them and try to understand which one is the more effective from the students’ point of view.

At this point it is important to realize what is actually asked within the survey about alternative teaching.
As it is immediately clear, question 1 is used to divide the students who have tried the type of alternative teaching in object during distance learning and those who have not.
After that, we get to the heart of the questions: question 2 is aimed at understanding which are the courses in which Italian students have had the opportunity to experiment with that specific type of remote alternative teaching. The question provides for an open answer, so that the student can freely write the name of the courses.
Question 3, on the other hand, is asked in order to understand how effective the alternative teaching method in question is in making students participate in distance learning.
Question 4 and Question 5 aim to investigate how effective these alternative teaching methods can be and how much they really help students to assimilate concepts.
Question 6, instead, is related to question 2: it aims to understand if it is possible, through these alternative teaching methods, to reduce the physical distance between the people involved in the online learning process. Thus, the purpose of this question is to understand

whether the alternative teaching method in question reduces the sense of loneliness that social isolation often generates.
Question 7, at the end, is a question that looks to the future, to how students imagine the post-pandemic. It is a question that tries to investigate the field of the unknown, tries to see beyond something that is not yet there, but will come and for which we need to understand what we can keep and what we have to throw away from this period of pandemic.

After all the alternative teaching methods have been proposed, the survey will move on to the next macro-section: "Considerations on teaching".

2.2.3. Consideration on teaching

The section analyzed in this paragraph is the shortest section of the questionnaire and is aimed at taking stock of the situation regarding distance learning, after the student has expressed his or her opinion on the various types of learning.

The questions in this section are only two and are all there to understand if the alternative remote teaching has an added value compared to frontal online teaching. Direct comparisons are made between the types of distance teaching.

Specifically, the questions asked are:

1) Taking an overall analysis of the courses in distance learning that you have taken, you preferred:

- *Courses based entirely on frontal teaching*
- *Courses based primarily on face-to-face instruction and supported in part by alternative instruction*
- *Courses based mainly on alternative teaching and supported in part by frontal teaching*
- *Courses based entirely on alternative teaching*

2) Beyond the grade you received on the exam, do you believe that the topics covered in alternative education have made a greater impact on you than those covered in frontal education?

- *Yes*
- *No*
- *Other*

Therefore, with these questions we try to make the student think about comparing frontal teaching with alternative teaching, trying to understand what he/she actually preferred during distance teaching and if the effort made by teachers to develop alternative teaching methods is actually repaid by the greater student satisfaction.

The third question is the key question of the section, as it asks students to examine the knowledge acquired during distance learning in order to draw a conclusion and understand

if the courses conducted with the help of alternative education have made the concepts better rooted in their knowledge.

2.2.4. Exams in distance learning

As it is possible to note in the graph 1 after the questions “Considerations on teaching” the next and the last batch of questions is “Exams in distance learning”.

In this section of the survey, students answer questions that are designed to understand how well the online exams are currently effective in assessing student preparation.

To better explain, online exams have radically changed the way of evaluating students and the purpose of these questions is to understand if online exams, as they are being conducted by Italian universities, can effectively evaluate the student or have flaws that need to be improved.

The first two questions are aimed at understanding the tendency that students have to cheat in both in-person and online exams in order to assess the differences:

1) Have you ever cheated during an in-person (pre-pandemic) exam?
- *Yes, often*
- *Yes, very few times*
- *No*
- *Other*

2) Have you ever been cheating during online exams?
- *Yes, often*
- *Yes, very few times*
- *No*
- *Other*

The third question, is aimed at dividing the students based on what types of exams they have had the experience of trying during distance learning:

3) In DAD you taken:
- *Only oral exams*
- *Written exams only*
- *More written than oral exams*
- *More oral than written exams*

The fourth question, on the other hand, is aimed at understanding what online software is most used to take exams:

4) What types of software has your university used to take online exams?
- *Zoom*

- *Google Meets*
- *Skype*
- *Microsoft Teams*
- *Respondus*
- *Other*

At this point in the survey a question about proctoring is asked to the student, specifically it is asked if they usually participate in online exams for which the teacher uses proctoring tools. A description has also been added explaining what proctoring tools are, as not everyone may be familiar with this term.

5) Were proctoring tools used to monitor student activities during exams?
Description: Proctoring tools are the software that allows you to monitor a student's device on exams or quizzes and capture as much data to decree whether they are cheating or not.

- *Yes, most teachers have made use of proctoring tools*
- *No, faculty have the camera on without using proctoring tools*
- *Some faculty used proctoring tools, but not all*
- *Other*

The sixth question is related to the second question too. This question is intended to confirm (or disprove) the common opinion that sees online exams as tests where cheating is much easier than in-person exams:

6) I believe that cheating during online exams is easier than in-person exams
Description: I ask you to answer according to what is your experience and what you happened to learn from the stories of your colleagues

1 – NOT agree at all
4 – Extremely agree

The seventh question is asked of students to see how widespread the practice is of having them use a side camera (which can be a cell phone camera) to make sure that no notes are hidden, or electronic devices are used during the test. The side camera provides a more complete view of the student, leaving little room for cheating.

7) Have you ever taken an online exam where the prof required the use of dual cameras (to get side control of the student)?

- *Yes, always*
- *No, never*
- *Yes, in most of the exams*
- *Yes, but only in a few exams*

The eighth question is related to the second question, in fact the student is asked which are the types of online exams where it is easier to cheat:

8) What do you think are the types of exams where it is easiest to cheat?

- *Oral exams*

- *Written exams*
- *Any type of exam*
- *None*
- *Other*

The last two questions in the survey deal with actual cheating methods. Students are asked to select from the choices what they think is the best method for cheating on oral exams and written exams:

9) What is the easiest method to copy during an online ORAL exam?

- *Keep the course material in a document in your PC and open it next to the web page where the exam is open.*
- *Ask for "help from the audience" by having a colleague who is also watching the exam send you the answer to the question the prof has just asked.*
- *"Carpeting" the room behind the pc (and the pc itself) with sheets of paper containing course material.*
- *Other*

10) What is the easiest method to copy during an online WRITTEN exam?

- *"Carpeting" the environment behind the pc (and the pc itself) with papers containing course material*
- *Using a cell phone or tablet outside of the camera's viewing range*
- *"Conceal" sheets containing course notes among the materials allowed to take the exam*
- *Other*

Chapter 3

Survey analysis – Students Answers

3.1.Collected answers in detail

This brief paragraph will detail the responses that the writer was able to collect through the administration of the survey.

Following for every question that has been asked to the respondents to the questionnaire will be shown the graph with the answers that have been given. This to be able to make a first analysis of what have been the trends of answer.

3.1.1. Collected answers: Introductory questions

The following data were collected in the introductory questions:

1) What degree path do you attend?

As it is possible to see in the pie chart below, the percentage of responses from the various training paths is homogeneous.

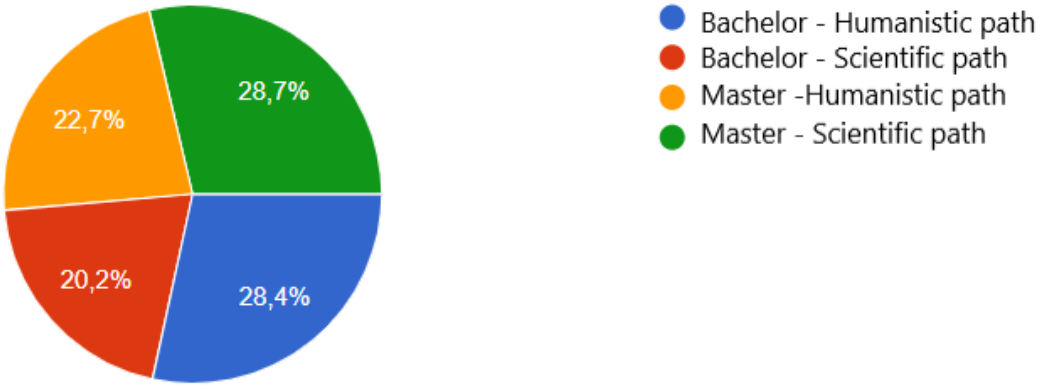


Figure 2: Degree path of the respondents

2) What university do you attend?

Responses came from 80 Italian universities located throughout the country.

There were universities that collected more responses than others. This is mainly due to the different number of universities.

The university that received the most responses was the Politecnico di Torino, with 39 responses. This was followed by the University of Turin with 21, and La Sapienza of Rome

with 20 responses. The fourth highest number of responses was the Federico II of Naples, with 14 responses.

The fact that the Politecnico di Torino found 39 responses was due to the fact that the writer is attending this university, thus reaching more people from this university than from other universities.

3) *During distance learning, what software are/was used to lecture?*

As it is possible to see in the chart below, the software most used by respondents to the survey was Microsoft Teams, followed by Zoom and Google Meet.

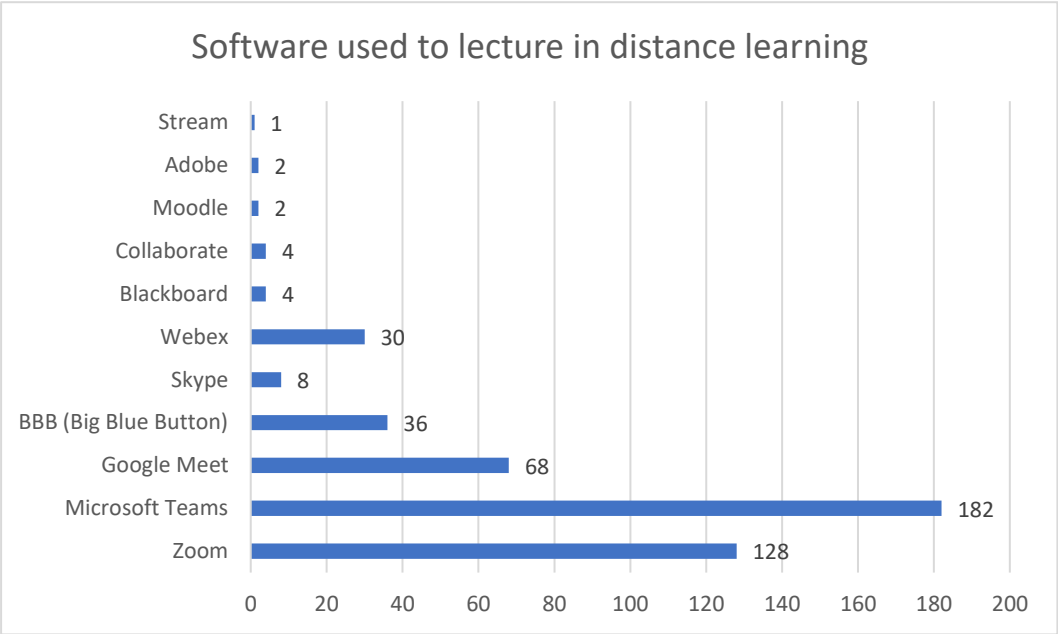


Table 1: Software used for distance learning

4) *Do you feel that the PC you have is suitable for taking lectures?*

As shown in the pie chart below, about 75% of people reported having an adequate computer for distance learning.

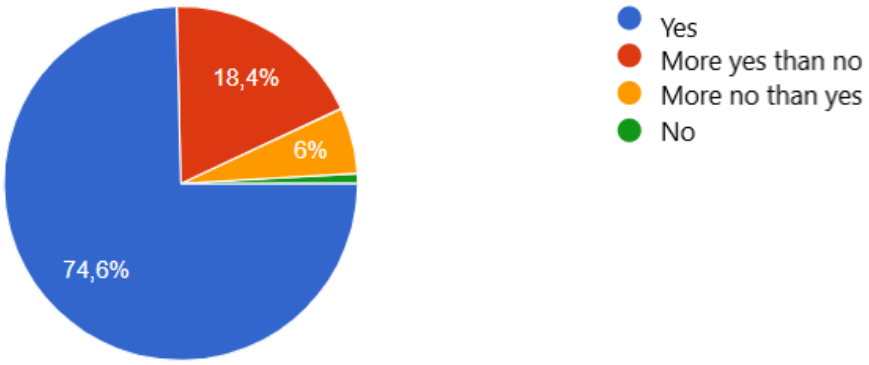


Figure 3: Computer conditions the survey respondents use

5) *Do you feel that the internet connection you have is suitable for taking lectures?*

As you can see in the pie chart below only 56% of students who responded to the questionnaire believe they have an adequate internet connection

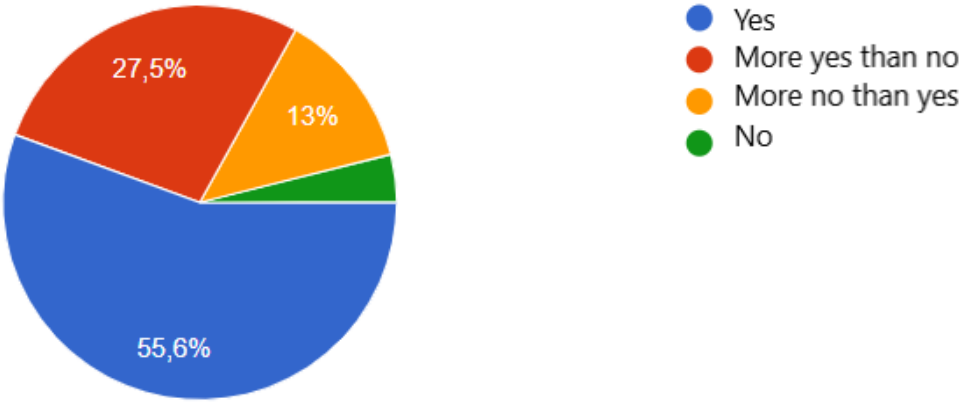


Figure 4: Internet connection condition the survey respondents use

6*) Do you feel that the study station (chair, desk, or any other support) you have is suitable for taking lectures?*

As you can see in the pie chart below only 56% of students who responded to the questionnaire believe they have an adequate study station.

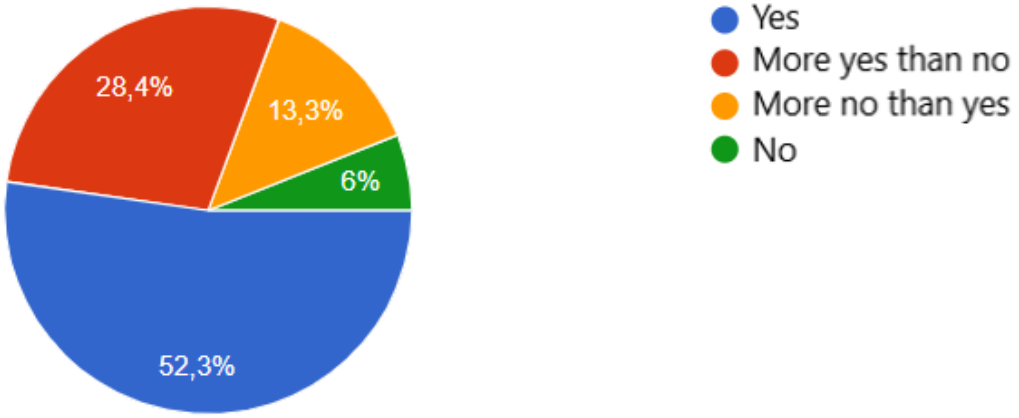


Figure 5: Study station condition the survey respondents have

7) What do you think is the greatest strength of distance learning?

For this question the writer has reorganized the answers in the categories illustrated in the chart below, to have more order among the concepts expressed by the respondents through the possibility to write freely the answer to this question.

The category that has been added to reorganize the answers with respect to those proposed in the text of the questionnaire is:

- To be able to better reconcile study with work, family and personal needs

In the graph below are shown the frequencies of response for each point of strength found. As it is possible to note, the one that has found a higher frequency is “Saving time spent traveling (e.g. home – university commute)”.

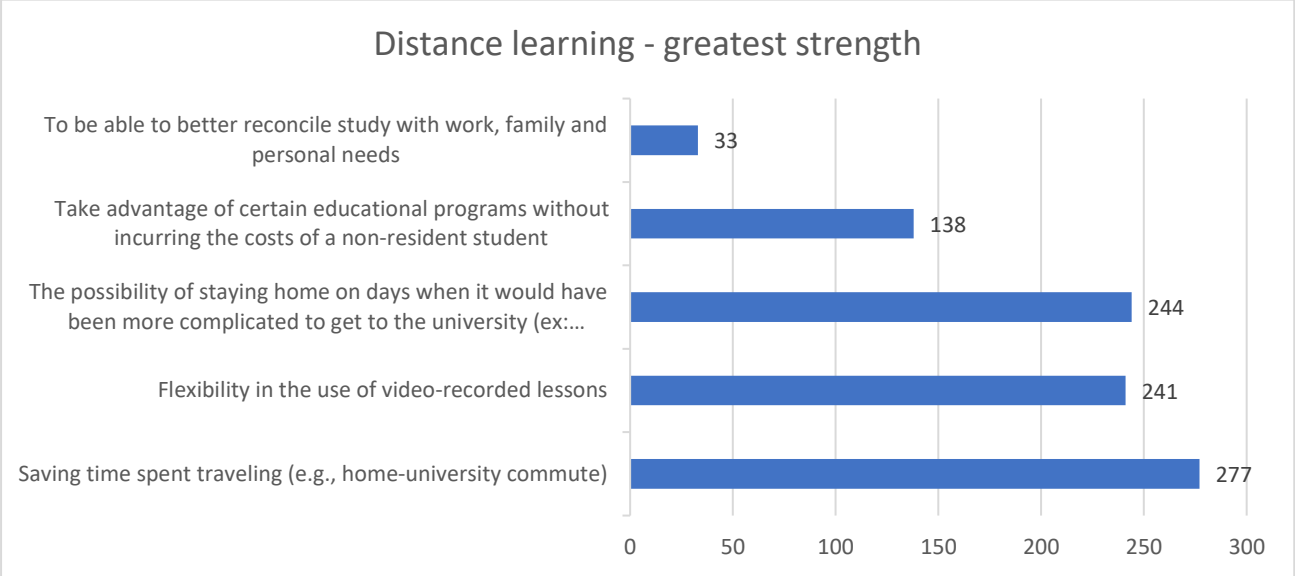


Table 2: Distance learning – Great strengths

8) What do you think is the biggest weakness of distance learning?

As with the question above, the writer has reorganized the answers in such a way

as to have a clearer and more precise situation of what the major weaknesses of distance learning are.

The categories that have been added to reorganize the answers with respect to those proposed in the text of the questionnaire are:

- None
- Physical and psychological damage caused by prolonged exposure to the computer while staying at home
- Low professors' skills in using information technology to teach classes

In the graph below are shown the frequencies of response for each point of weakness found. As it is possible to note, the one that has found a higher frequency is “The greater ease in getting distracted and losing focus during class”.

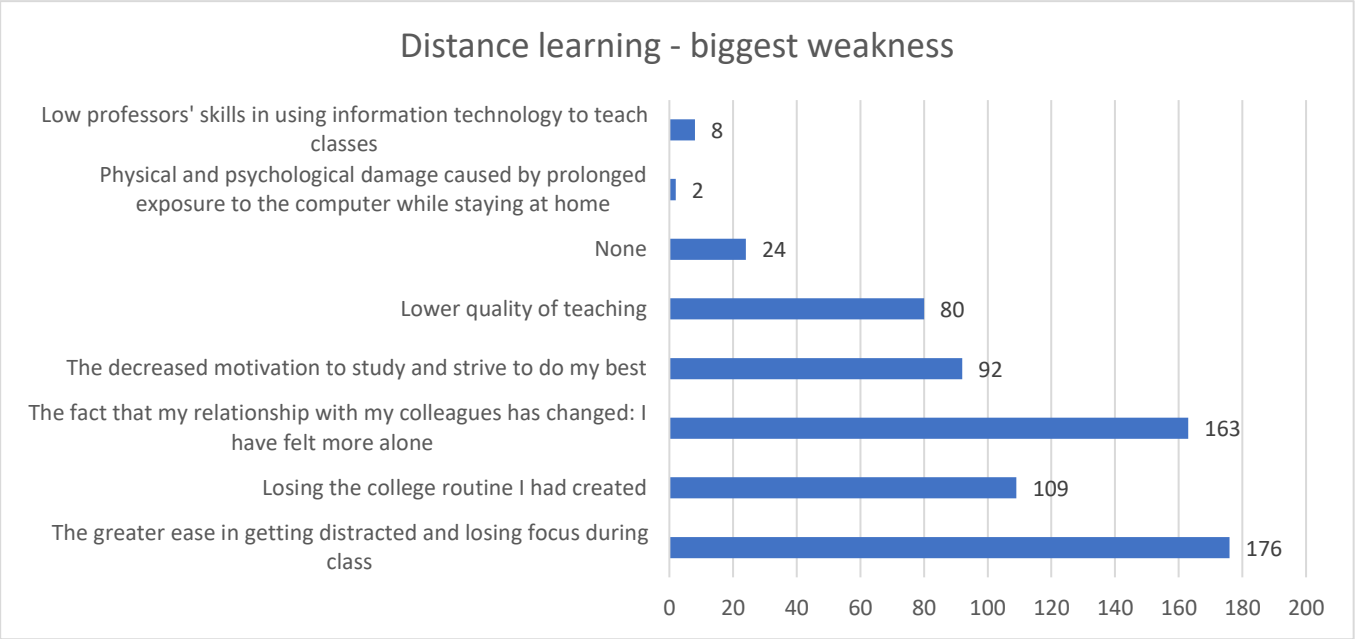


Table 3: Big weaknesses

*8) After taking classes in distance learning, I feel less ready for exams than when I took in-*person (pre-pandemic)

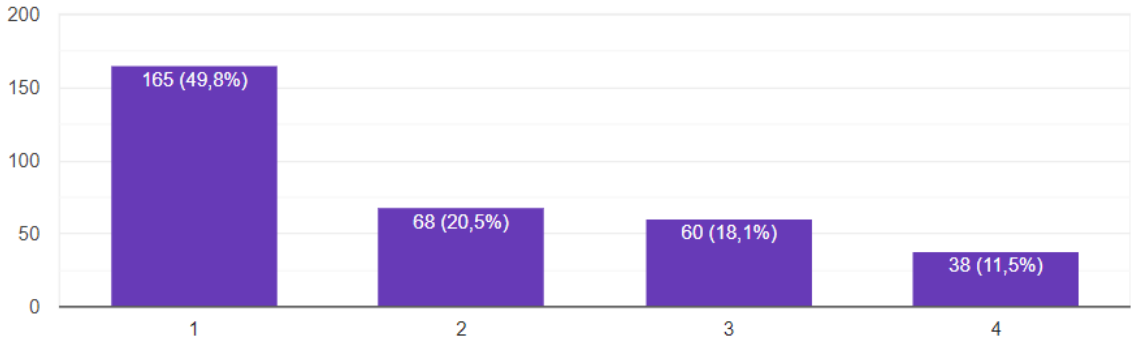


Table 4: Quality of teaching in distance learning

Through this question, we can see that about 70% of respondents to the questionnaire report that they have not found a substantial difference in their knowledge of university course content. Therefore, they feel ready to face the exams exactly as when they follow the lessons of the in-person courses. See the chart below for details.

10) By taking the courses in distance learning I am able to keep up with the lessons of the courses more than when I was taking in-person (pre-pandemic)

Through this question it is possible to note that 65% of the students who answered the questionnaire consider distance learning as something that favors study, making them keep up with the lessons more than they do with the lectures. See the chart below for details.

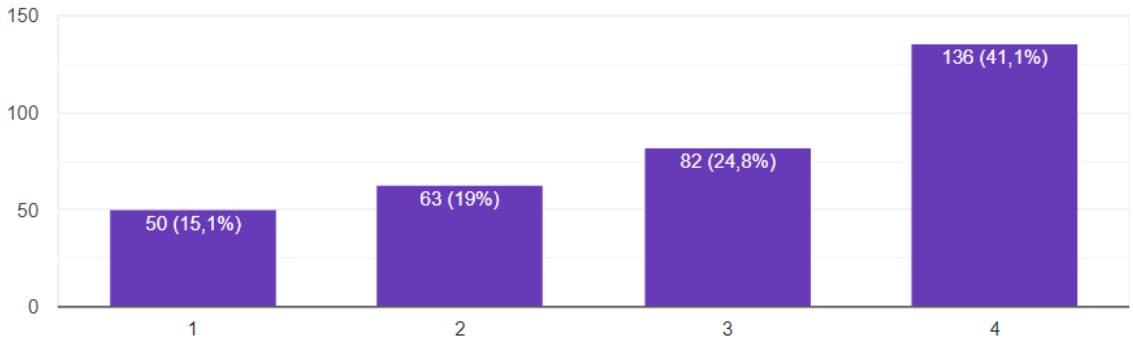


Table 5: Ease in keeping up with classes during distance learning

3.1.2. Collected answers: Main teaching methods (frontal teaching and alternative methods

In the following two sub-sections, the analysis of the answers received regarding the different types of distance learning will be carried out.

3.1.2.1. Frontal teaching method

The following data were collected for frontal teaching method during distance learning:

1) During frontal lectures in distance learning, I often feel poorly involved

For this question there is no clear trend towards answers 1-2 (not agree at all - do not really agree) or 3 - 4 (quite agree - extremely agree). It is easy to note that the answers are mostly homogeneous among all 4 points

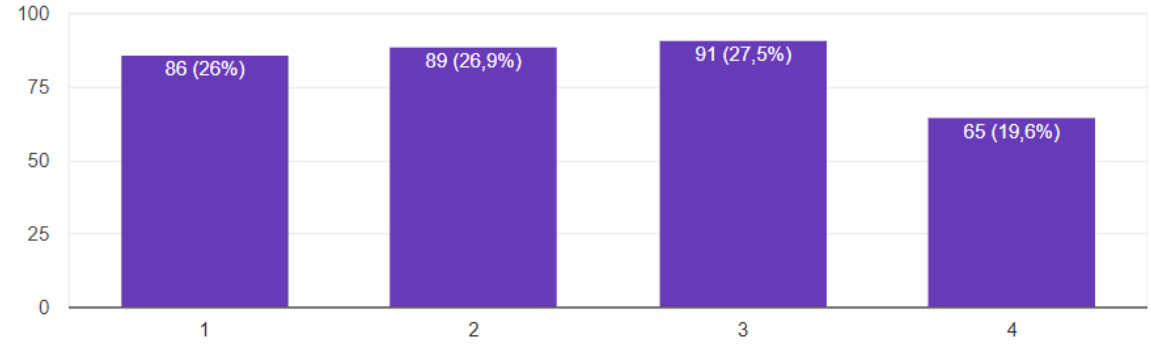


Table 6: Frontal teaching involvement

2) Lectures using the frontal teaching approach are a good way to approach distance learning

This question denotes that in general the students surveyed are quite satisfied with frontal teaching, about 62% in fact agree with the above statement. Of these, most (121 people) quite agree with the statement.

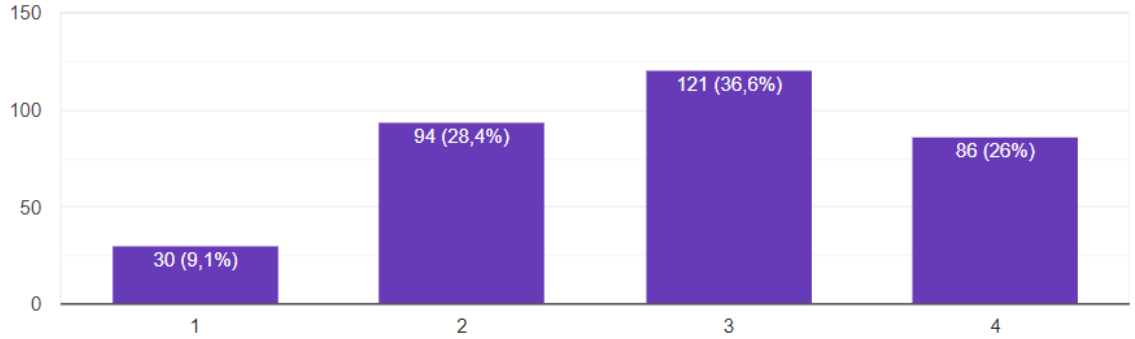


Table 7: Frontal teaching good way to conduct lessons in distance learning

3) During the lessons in distance learning with frontal modality I assimilate better the concepts in comparison to when I attended the lessons with the same approach in presence (pre-pandemic).

Responses to this question denote that nearly 60% of the students who responded to the survey disagreed with the statement. It is therefore clear that frontal teaching in remote mode is not considered superior to frontal teaching in traditional mode by 60% of respondents.

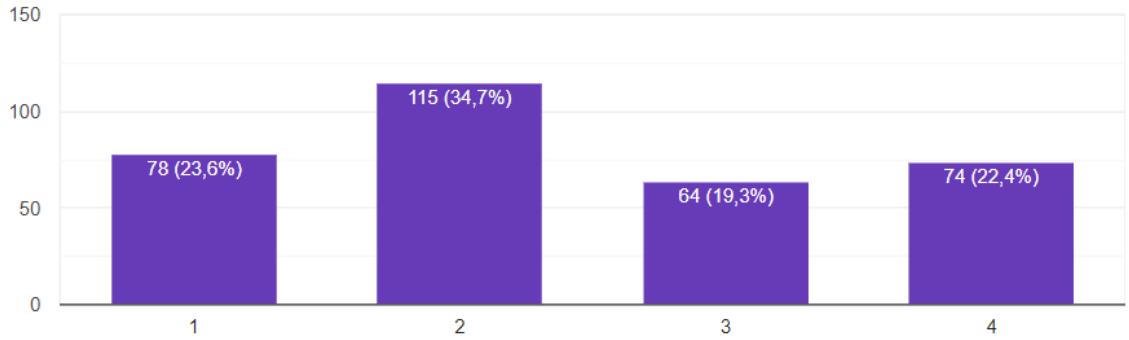


Table 8: Frontal teaching assimilation of contents

4) *What do you think is the greatest advantage of distance learning conducted through frontal teaching?*

This question was also reworked by the writer to better organize the responses entered by respondents via the "other" box. This time, however, it was not necessary to add other responses that could express common concepts that the responses entered in the question text did not already include.

From the graph below we can see that surely what is seen as the greatest advantage of distance learning carried out in frontal mode is the fact of "Not having to actively participate".

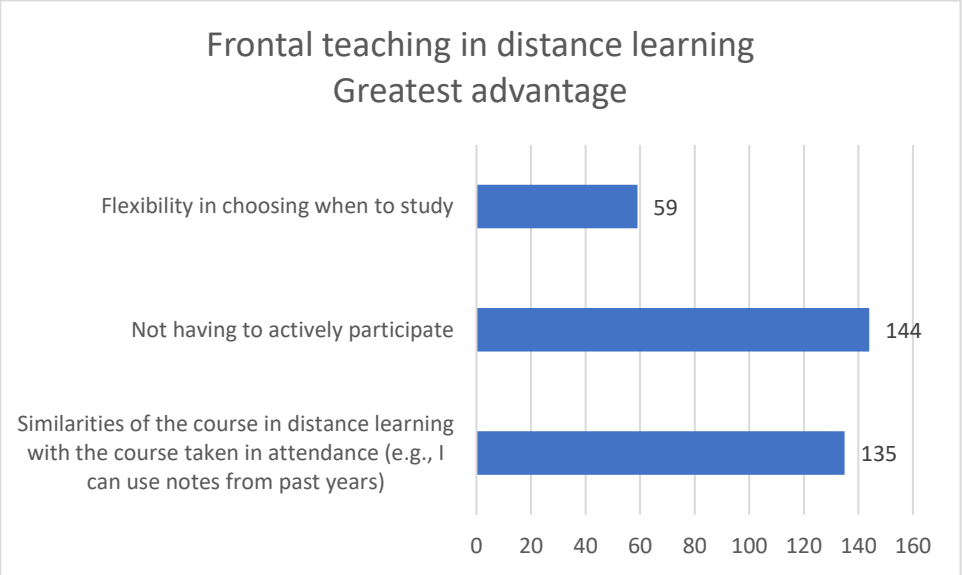


Table 9: Great advantages

5) What do you think is the worst disadvantage of distance learning conducted through frontal teaching?

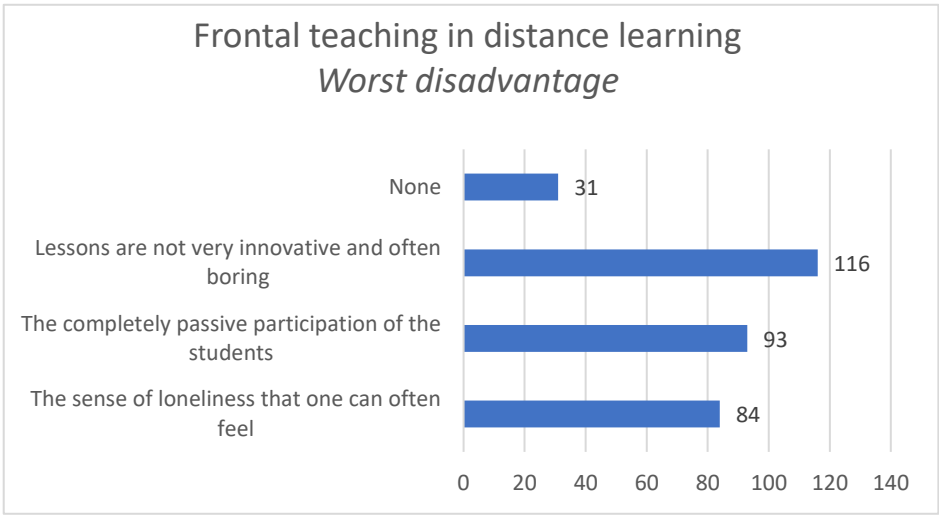


Table 10: Big disadvantages

We are once again faced with a question whose answers have been reworked to be better categorized. In this case, the only answer added by the writer is:
none
Many people, 31 to be precise, state that they do not find any disadvantages in frontal distance learning.
However, it is easily found that the most shared disadvantage among respondents is that "Lessons are not very innovative and often boring".

3.1.2.2. Alternative teaching method

Inherent responses to questions about alternative teaching methods will be outlined in this sub-paragraph. As mentioned in the previous chapter, these responses were collected from the people who answered yes to the question below:

1) Are you having opportunities during distance learning to experience one or more types of alternative teaching implemented by your professors?

The pie chart below shows that people who have experienced alternative teaching methods during classes from remote are about exactly half of the respondents, 48.3%. Overall, the amount of respondent who declared to have tried at least one alternative teaching method are 160/331.

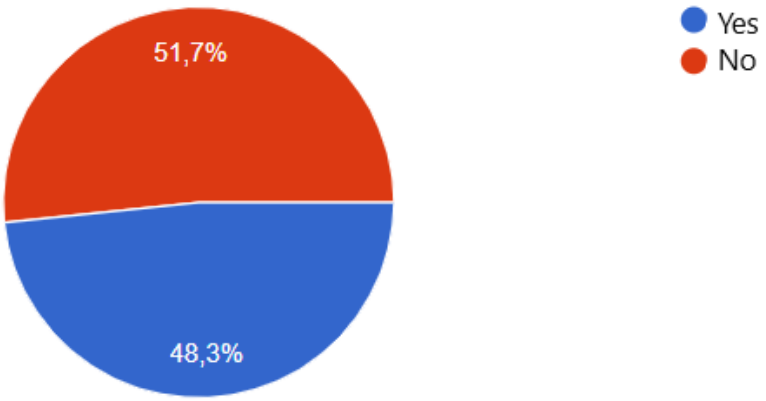


Figure 6: Respondents who have tried alternative teaching in distance learning

3.1.2.2.1. Flipped Classroom

People who reported trying flipped classroom at least once during distance learning are 72/160, which is 45%.

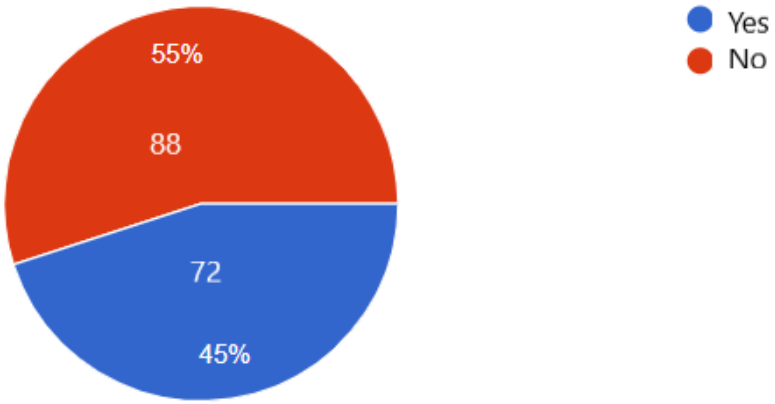


Figure 7: Respondents who have tried flipped classroom

2) I think the flipped classroom mode helps make us students feel more involved, thus allowing us to be an active part of the lesson

88% of respondents agree with this statement. Thus, the flipped classroom plays a key role in making the students surveyed feel an active part of the lesson.

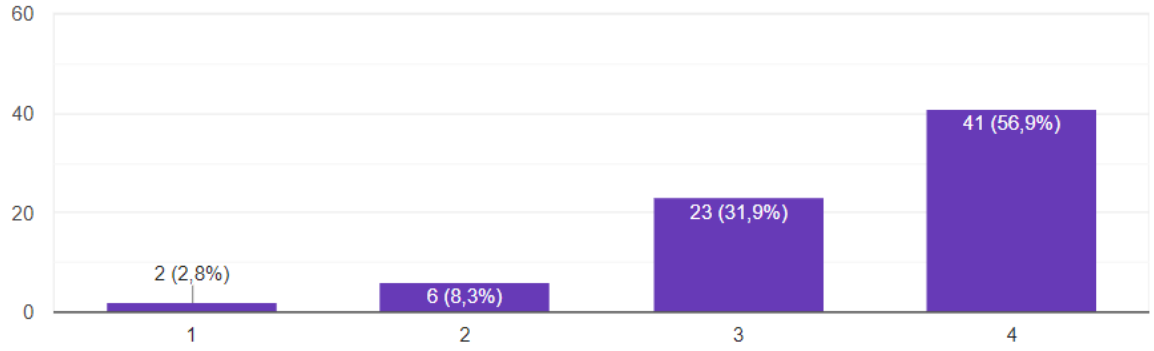


Table 11: Flipped classroom involvement

3) I believe that the flipped classroom is an effective way to best learn the concepts of many college courses in distance learning

Again, more than 80% of respondents (83% to be precise) agreed with the statement. There is no doubt, therefore, that for most of these people, the Flipped classroom is an effective method for learning university concepts.

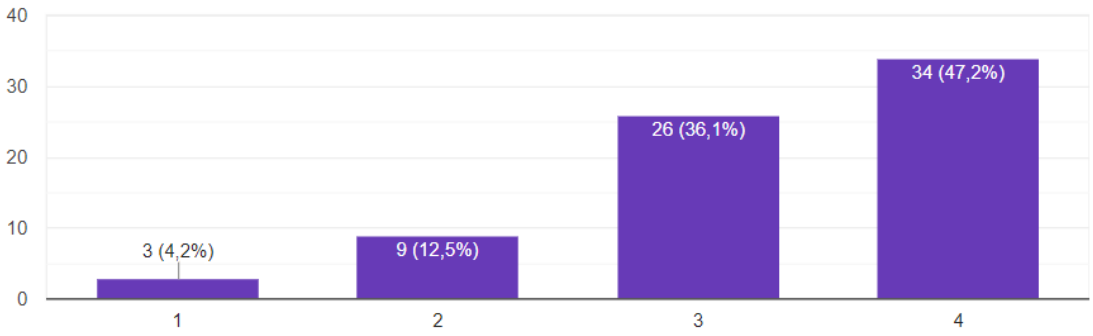


Table 12: Flipped classroom effective method

4) During the lessons in distance learning with "flipped classroom" mode I quickly assimilate the concepts

42/72 people who responded to this question stated that thanks to the flipped classroom they are able to quickly assimilate concepts.

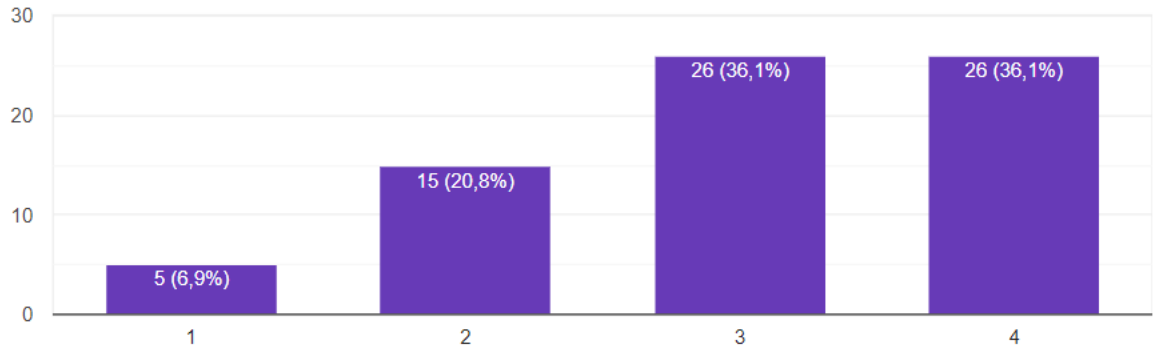


Table 13: Flipped classroom quick method to assimilate concepts

5) I believe the flipped classroom method helps reduce the physical distance with colleagues and professors

For this question regarding the flipped classroom, respondents also answered almost in agreement with the statement.

In fact, 80% find that the flipped classroom helps to break down physical distance.

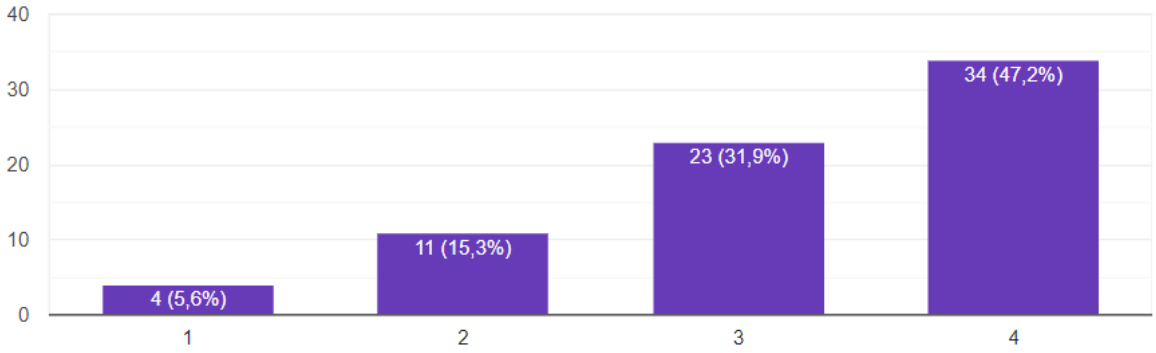


Table 14: Flipped classroom reduces physical distances

6) Do you think the flipped classroom could be a viable alternative method that could also be used in what will be post-pandemic?

86% of respondents answered yes to this question.

3.1.2.2.2. Project work

People who reported trying project works at least once during distance learning are 139/160, which is 86%.

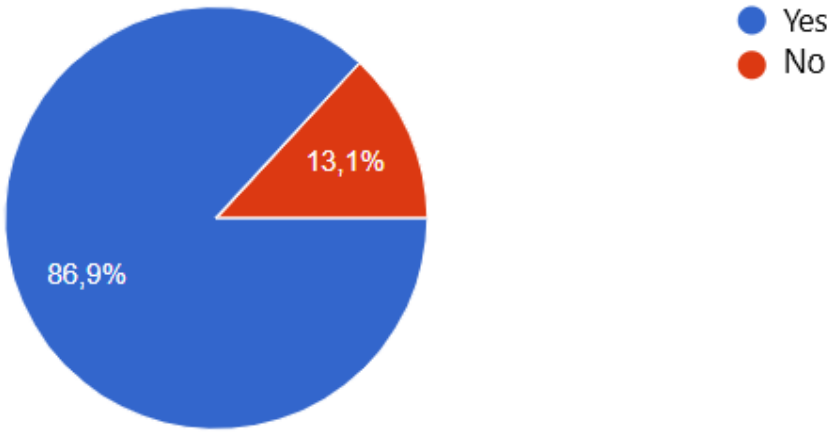


Figure 8: Respondents who have tried project works

2) *I think the project works mode helps make us students feel more involved, thus allowing us to be an active part of the lesson*

As with the flipped classroom, this question also found a very high percentage of people who responded in agreement with the statement, about 82%.

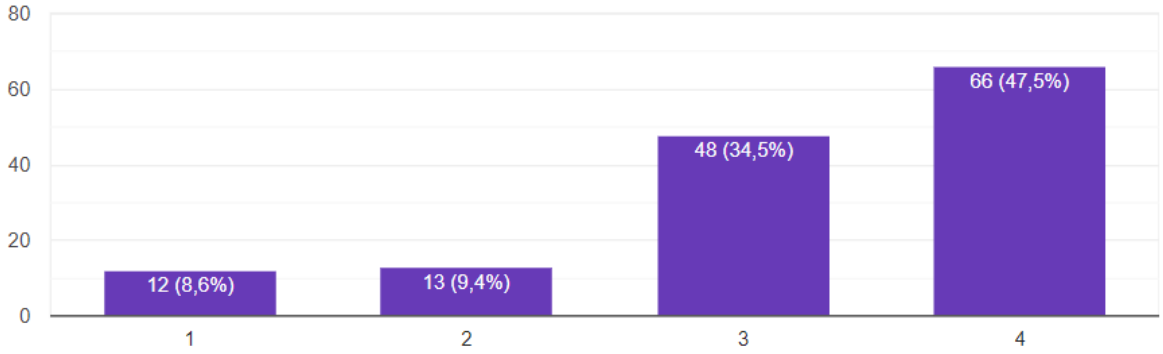


Table 15: Project works involvement

3) I *believe that the project works is an effective way to best learn the concepts of many college courses in distance learning*

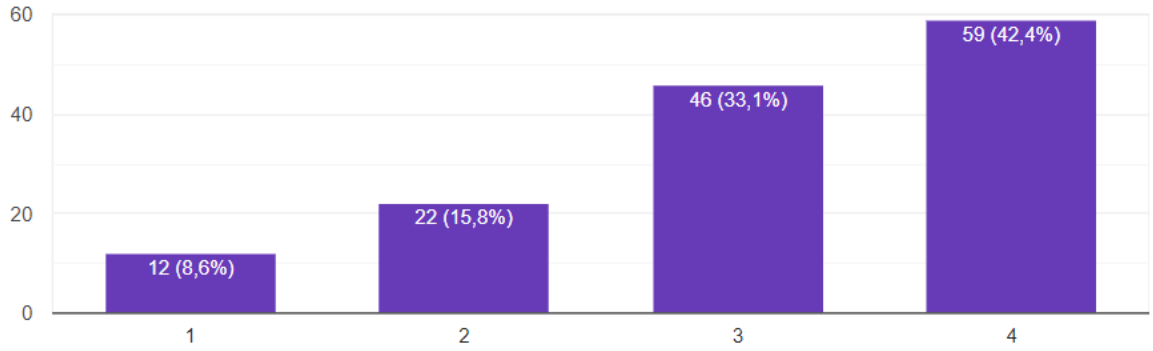


Table 16: Project works effective method

This question also found very similar outcomes to the equivalent for the flipped classroom. In fact, even in this case, 80% of the students agreed with what the sentence states.

4) During the lessons in distance learning with "project works" mode I quickly assimilate the concepts

In this case, respondents were divided as follows:
-40% in range 1 - 2 (Not agree at all – Do not really agree)
-60% in range 3 – 4 (Quite agree – Extremely agree)

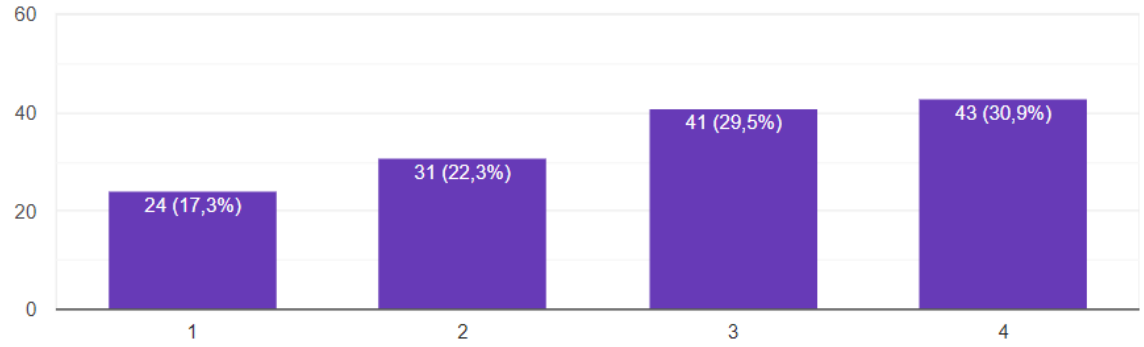


Table 17: Project work quick method to assimilate concepts

5) I *believe the project work method helps reduce the physical distance with colleagues and professors*

About 78% of respondents agreed with the statement. A very similar result to that found in the equivalent question regarding the flipped classroom.

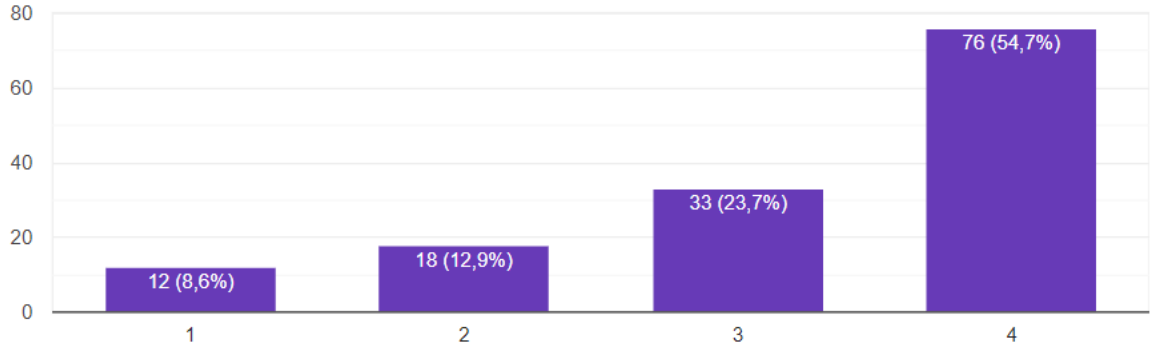


Table 18: Project works reduces physical distances

6) Do you think the project work could be a viable alternative method that could also be used in what will be post-pandemic?

81% of respondents answered yes to this question.

3.1.2.2.3. Challenges

People who reported trying Challenges at least once during distance learning are 24/160, which is 15%.

Challenges, because of their difficulty in organization (it is not always easy to find a company able to commission a real project from students), are much less widespread than other alternative teaching methods.
In addition, during the darkest months of the pandemic, the situation of many companies was certainly not flourishing, which contributed even more to discontinue the provision of initiatives of this type.

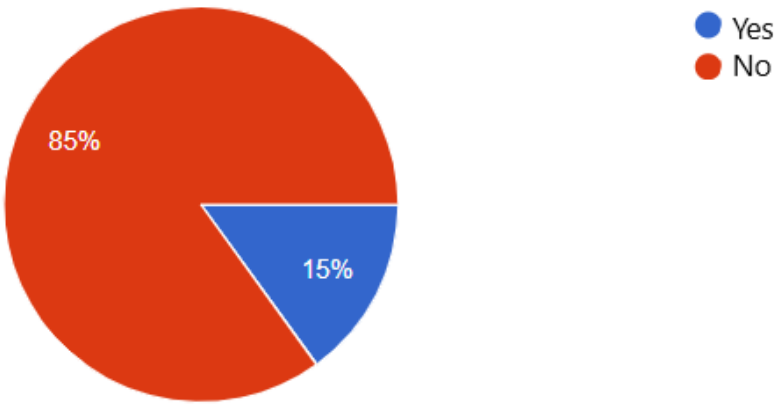


Figure 9: Respondents who have tried Challenges

2) I think the Challenge mode helps make us students feel more involved, thus allowing us to be an active part of the lesson

Again, respondents are predominantly all (except 2) in agreement with the statement.

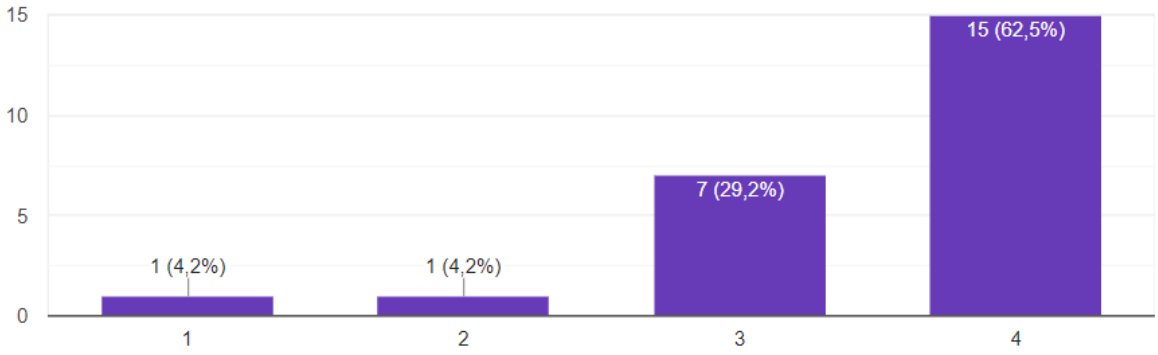


Table 19: Challenge involvement

3) I believe that the challenge is an effective way to best learn the concepts of many college courses in distance learning

The result for this statement is very similar to the previous result in which almost all respondents agree with the statement.

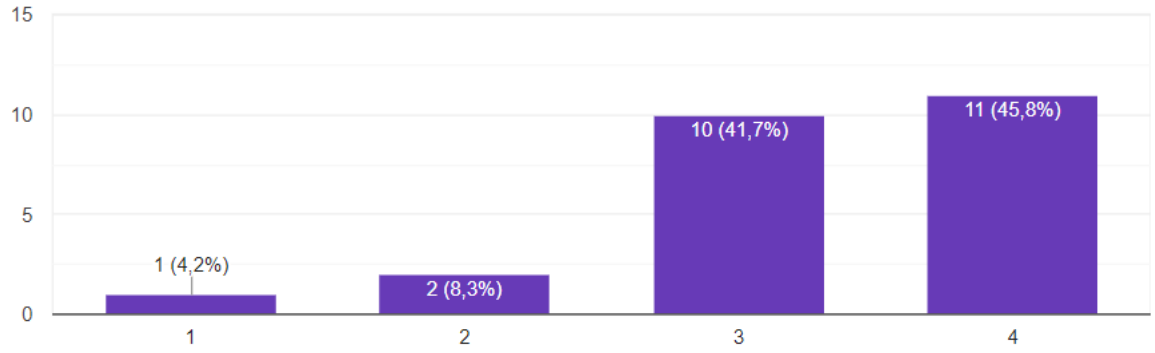


Table 20: Challenge effective method

4) During the lessons in distance learning with "challenge" mode I quickly assimilate the concepts

80% of respondents agreed with the statement.

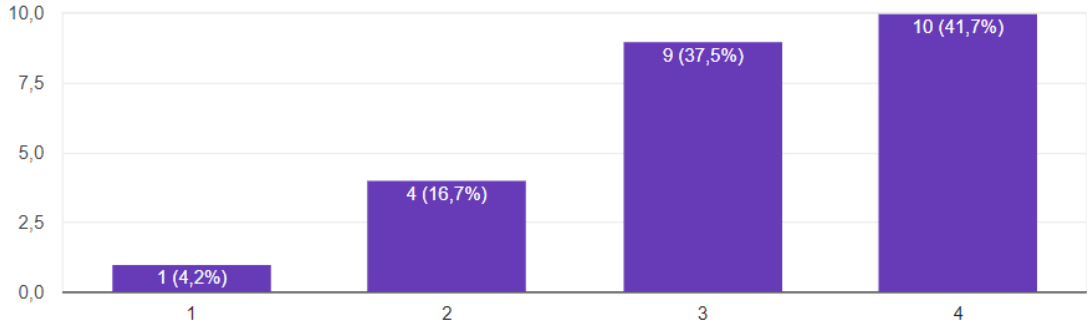


Table 21: Challenge quick method to assimilate concepts

5) I believe the challenge method helps reduce the physical distance with colleagues and professors

Again, 80% of respondents agreed with the statement.

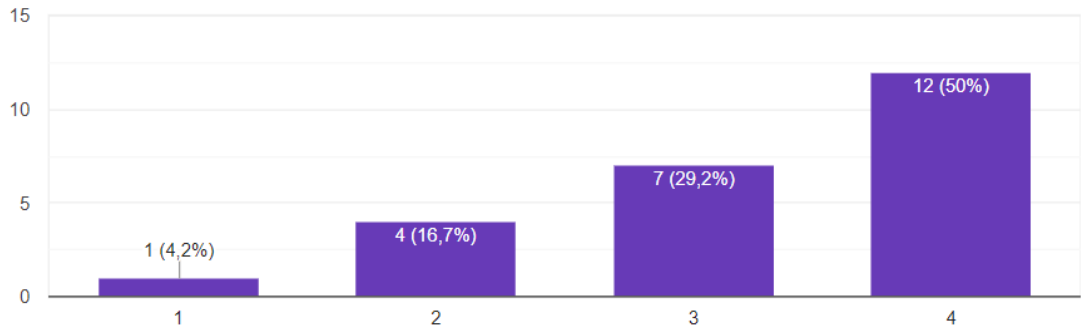


Table 22: Challenges reduces physical distances

6) Do you think the challenges could be a viable alternative method that could also be used in what will be post-pandemic?

96% of respondents answered yes to this question.

3.1.2.2.4. Peer-to-peer learning

People who reported trying Peer-to-peer learning at least once during distance learning are 40/160, which is 25%.

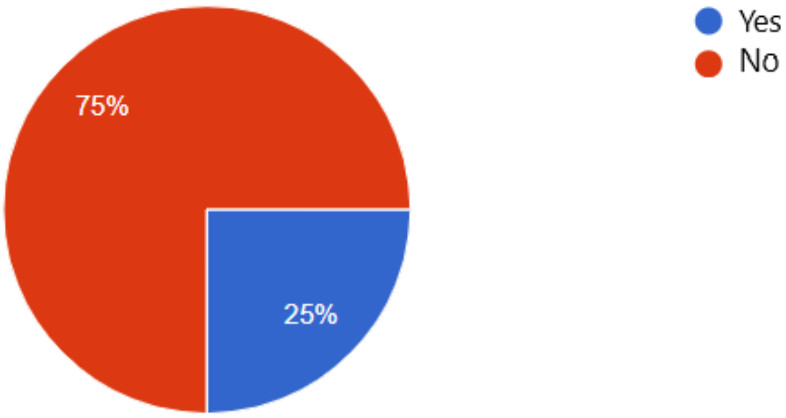


Figure 10: Respondents who have tried peer-to-peer learning

2) I think the peer-to-peer learning mode helps make us students feel more involved, thus allowing us to be an active part of the lesson

80% of respondents agreed with the statement. This finding is similar to that found for the same question in the alternative teaching methods analyzed above.

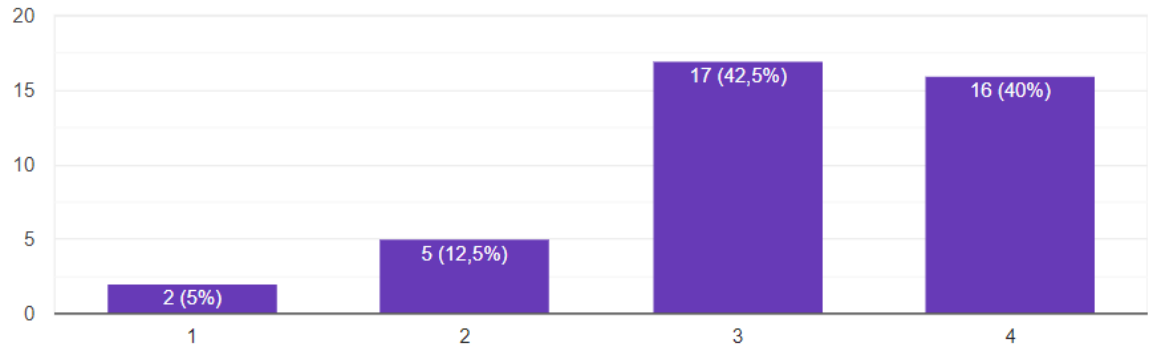


Table 23: Peer-to-peer learning involvement

3) I believe that the peer-to-peer learning *is an effective way to best learn the concepts of many college courses in distance learning*

Also for this question, the result is similar to the alternative teaching tools analyzed so far, in fact, it shows that 70% agree with the sentence

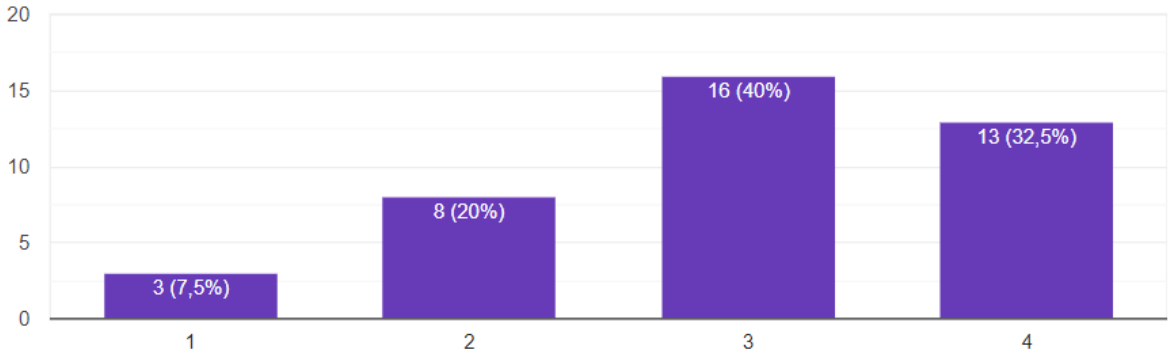


Table 24: Peer-to-peer learning effective method

4) During the lessons in distance learning with "peer-to-peer learning" *mode I quickly assimilate the concepts*

In this case, it can be seen that the sample of people who answered this question is divided into 50% agreeing with the statement and the other 50% disagreeing with the statement.

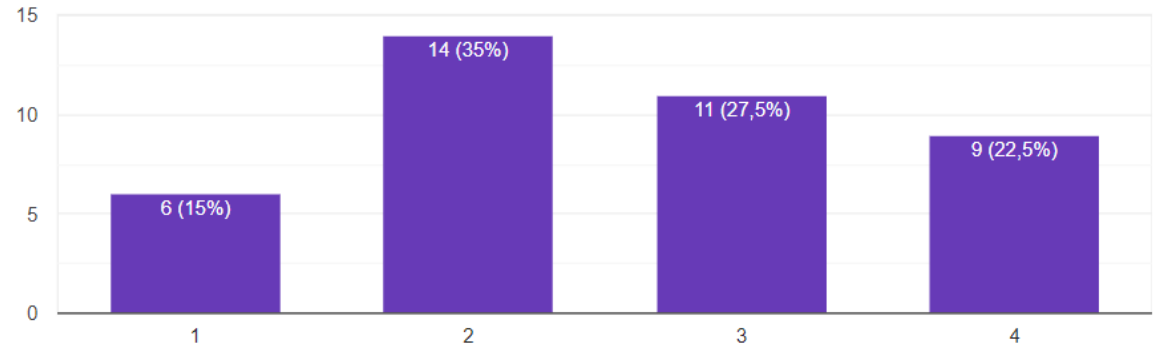


Table 25: Peer-to-peer learning quick method to assimilate concepts

5) I believe the peer-to-peer learning *method helps reduce the physical distance with colleagues and professors*
Il peer-to-peer, with 70% agreeing with this statement, prove to be a valuable way for most respondents to reduce the physical distance between colleagues and professors

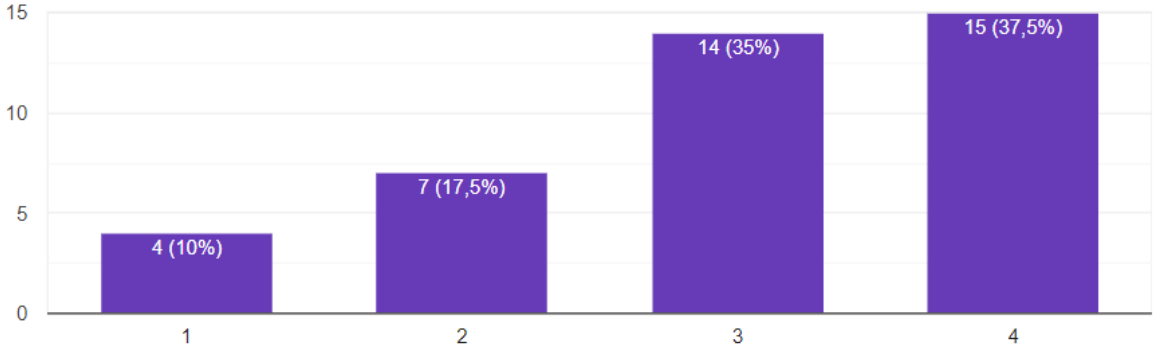


Table 26: Peer-to-peer learning reduces physical distances

6) Do you think the peer-to-peer learning could be a viable alternative method that could also be used in what will be post-pandemic?

75% of respondents answered yes to this question.

3.1.2.2.5. Group work

People who reported trying group work at least once during distance learning are 92/160, which is 57,5%.

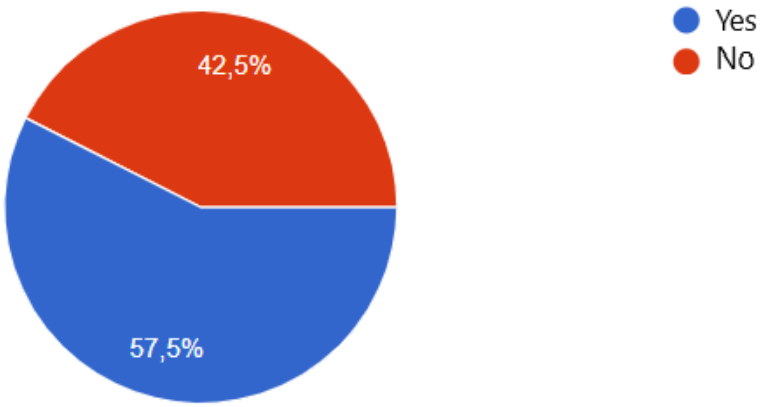


Figure 11: Respondents who have tried Group works

2) I think the group work mode helps make us students feel more involved, thus allowing us to be an active part of the lesson

About 90% of respondents agreed with the statement.

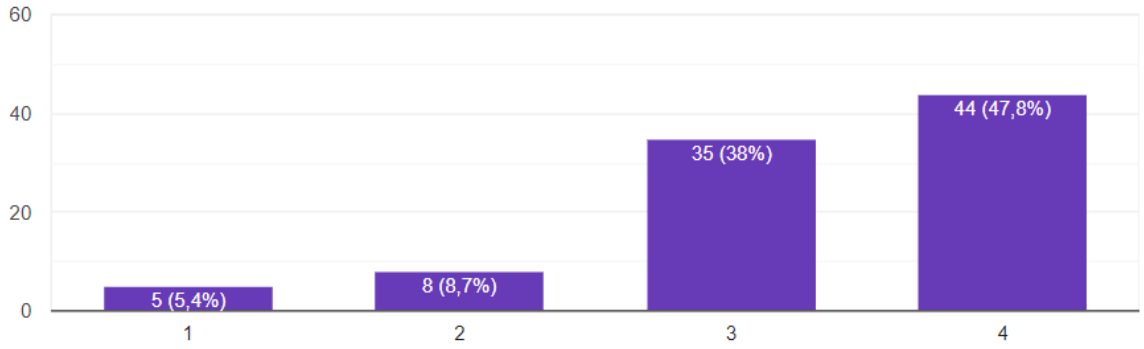


Table 27: Group work involvement

3) believe that the group work is an effective way to best learn the concepts of many college courses in distance learning

The "group work" method is also considered an effective method by about 80% of the questionnaire respondents.

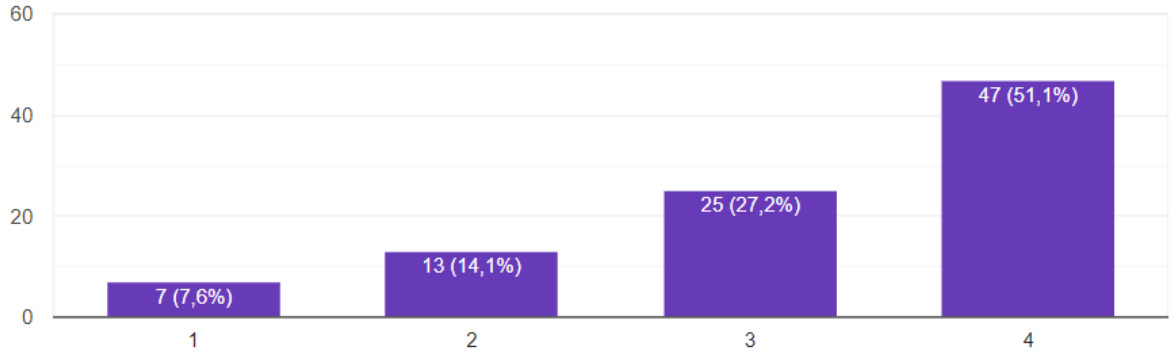


Table 28: Group work effective method

4) During the lessons in distance learning with " group work " mode I quickly assimilate the concepts

It can be inferred that group work is considered an good way to assimilate concepts. Again, the majority of people who answered to this question is in agreement with the statement.

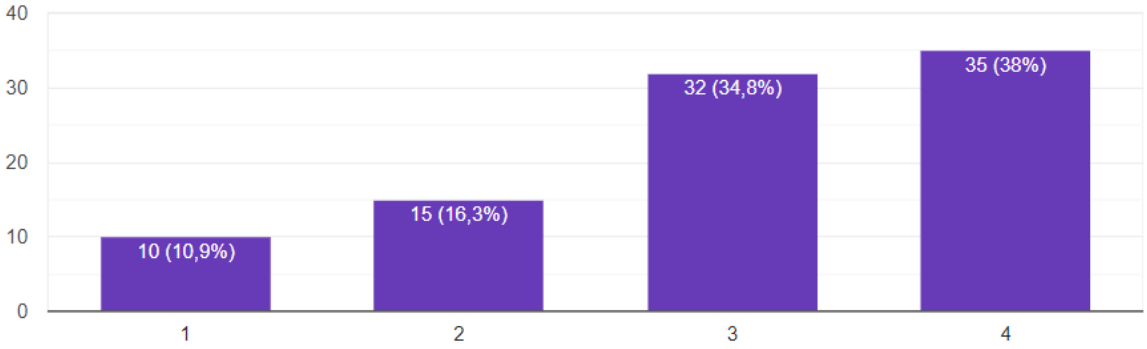


Table 29: Group work quick method to assimilate concepts

5) *I believe the group work method helps reduce the physical distance with colleagues and professors*

*A*gain, without a shadow of a doubt, the group work method also proves to be an excellent method among respondents to reduce the physical distance between colleagues and professors

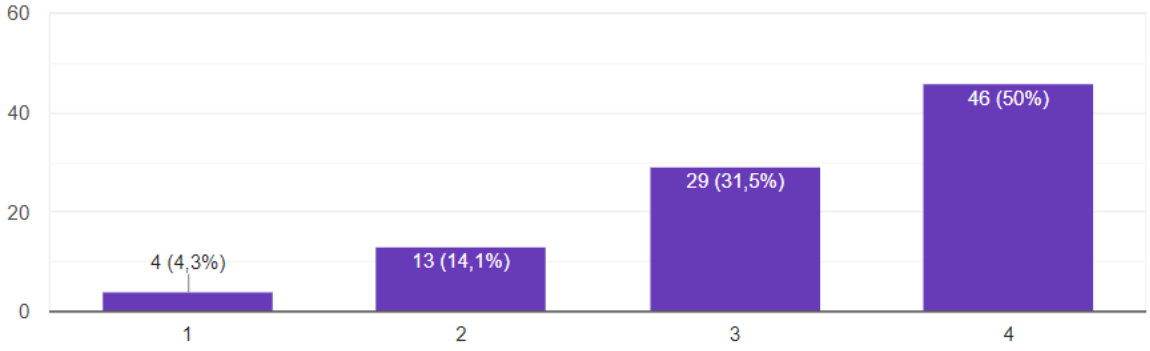


Table 30: Group work reduces physical distances

6) *Do you think group works could be a viable alternative method that could also be used in what will be post-pandemic?*

87% of respondents answered yes to this question.

3.1.2.2.6. Gamification

People who reported trying Gamification at least once during distance learning are 22/160, which is 13,8%.

Gamification, like challenges and peer-to-peer learning, was also found to be one of the least experienced alternative teaching methods by respondents.
Again, this is due to the fact that it is often difficult for teachers to organize a course that is related to Gamification, a lot of inventiveness but above all a lot of organization is required, and course topics do not always fit with this teaching method.

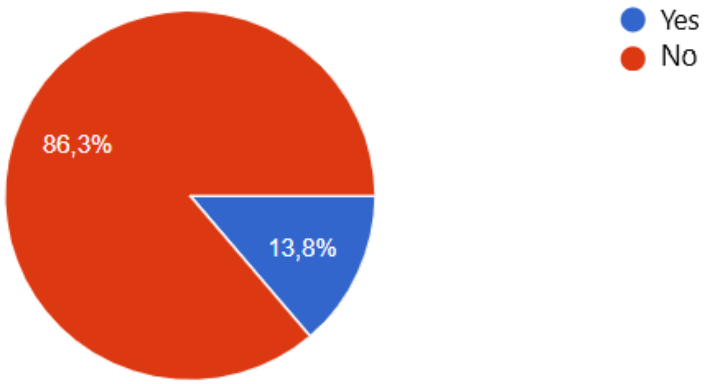


Figure 12: Respondents who have tried gamification

2) I think the gamification mode helps make us students feel more involved, thus allowing us to be an active part of the lesson

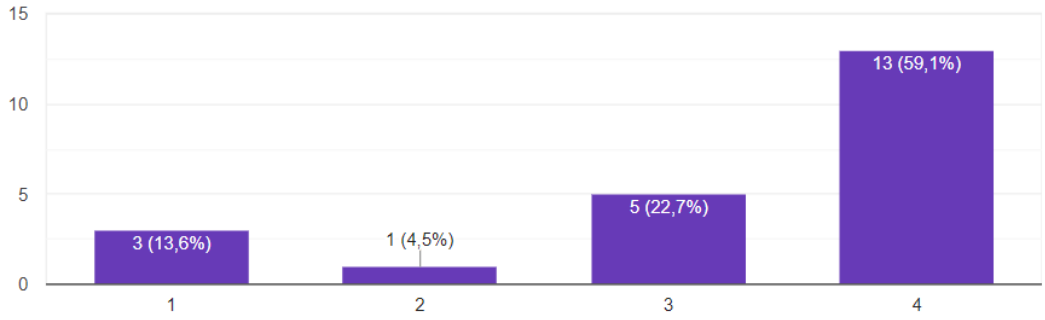


Table 31: Challenge involvement

Also in the case of gamification, for this question the majority of respondents (80%) agreed with the statement.

3) I believe that the gamification is an effective way to best learn the concepts of many college courses in distance learning

Again, Gamification turns out to be highly valued by students, on par with the other methods analyzed above.

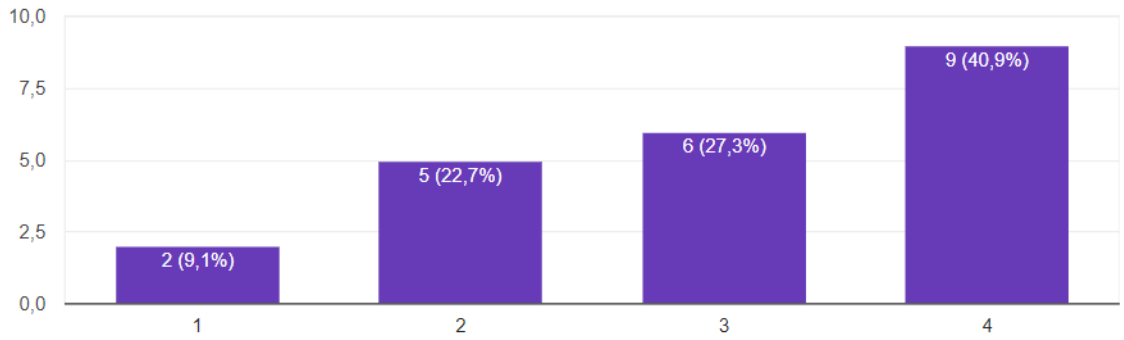


Table 32: Gamification effective method

4) During the lessons in distance learning with " Gamification" mode I quickly assimilate the concepts

Gamification proves to be for about 60 percent of respondents a method that allow to quickly assimilate the concepts.

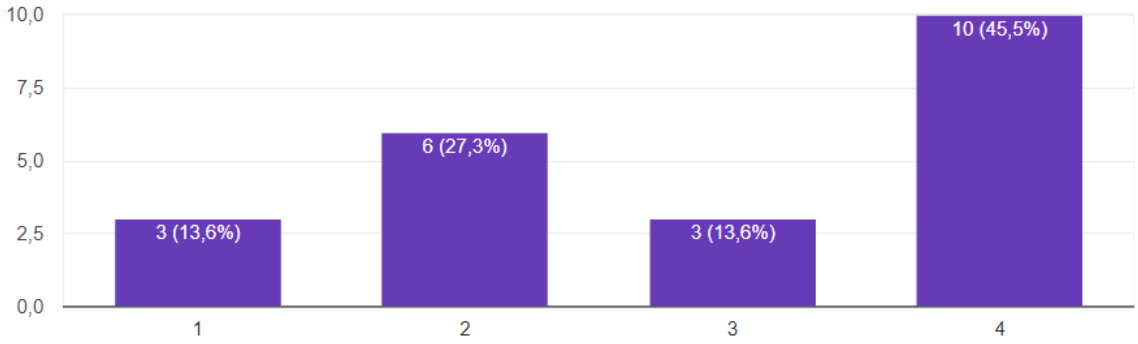


Table 33: Gamification quick method to assimilate concepts

5) *I believe the gamification method helps reduce the physical distance with colleagues and professors*

Gamification, like other alternative teaching tools is seen by most respondents as something very useful in reducing physical distance with colleagues and professors

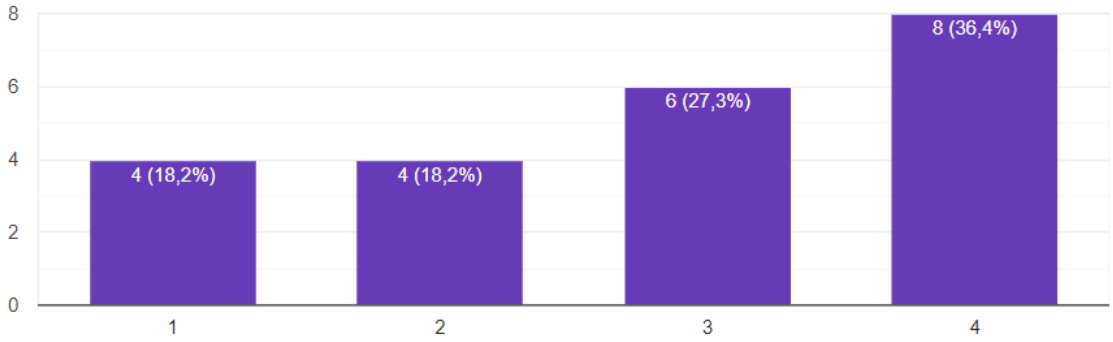


Table 34: Gamification reduces physical distances

6) *Do you think gamification could be a viable alternative method that could also be used in what will be post-pandemic?*

72% of respondents answered yes to this question.

3.1.3. Collected answers: Considerations on teaching

1) Taking an overall analysis of the courses in distance learning that you have taken, you preferred:

This question shows that among the students surveyed, 47% of them prefer courses that are based on frontal teaching and supported with alternative teaching.
Only the 30% of them said that prefer the courses based on frontal teaching only.

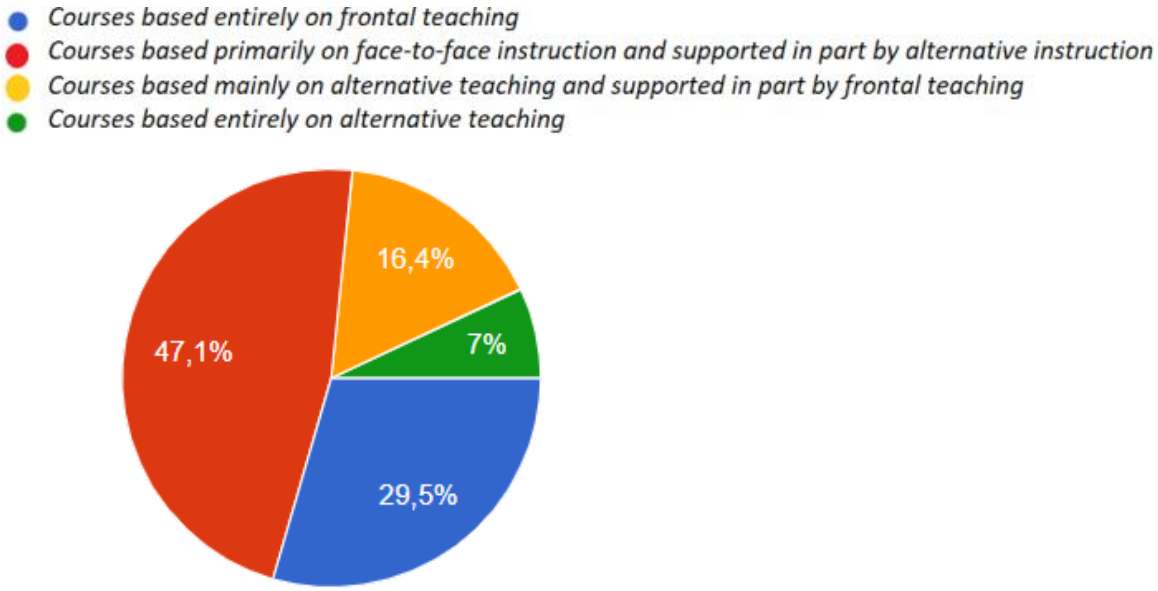


Figure 13: Online teaching methods respondents' preferences

2) Beyond the grade you received on the exam, do you believe that the topics covered in alternative education have made a greater impact on you than those covered in frontal education?

Fifty percent of people responded that courses that partly included remote alternative teaching had a greater impact in their training than those covered only by online frontal teaching. It is also worth mentioning that only 6% of people said that it is not influential how the courses are conducted.

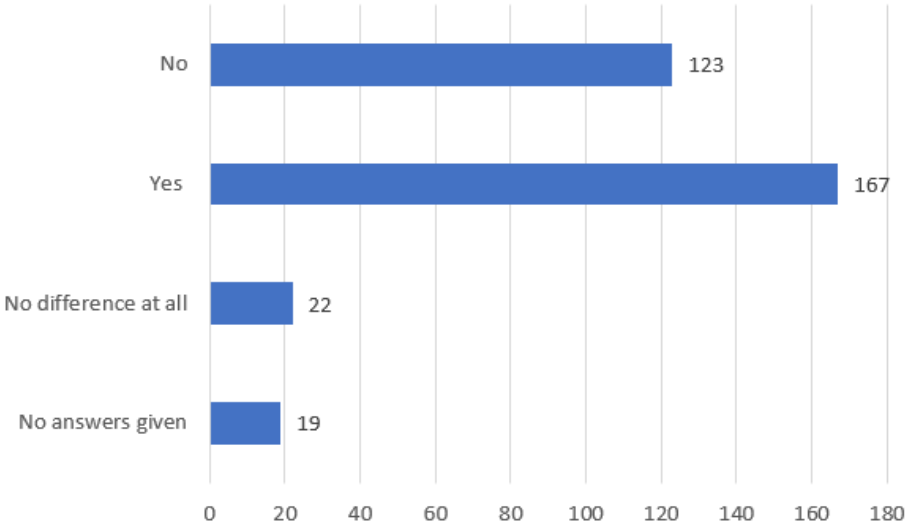


Table 35: Alternative teaching impact on students

3.1.4. Collected answers: Exams in distance learning

1) Have you ever cheated during an in-person (pre-pandemic) exam?

Two-thirds of people (67%) said they never cheated during an in-person exam. Only 4% of the respondents said they have often copied on an in-presence exam. This confirms that indeed the phenomenon of cheating during in-presence exams is not that widespread.

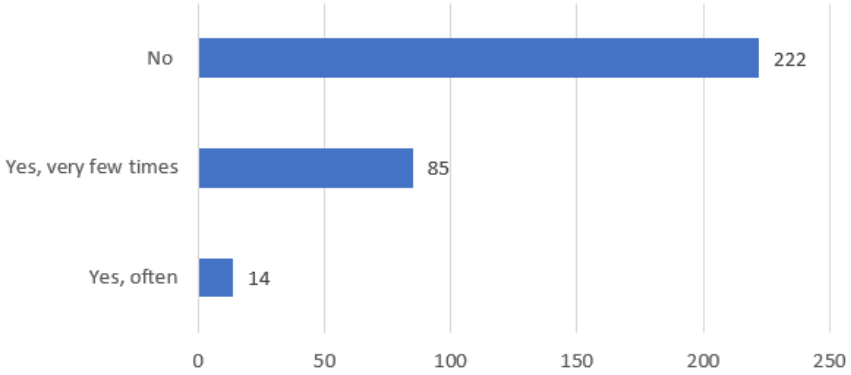


Table 36: Cheaters in in-person exams

2) Have you ever been cheating during online exams?

Speaking of online exams, however, the percentage of people who said they had never cheated during an exam was reduced to 48%.
It is also interesting to note that people who said they cheated often during online exams increased to 8%.

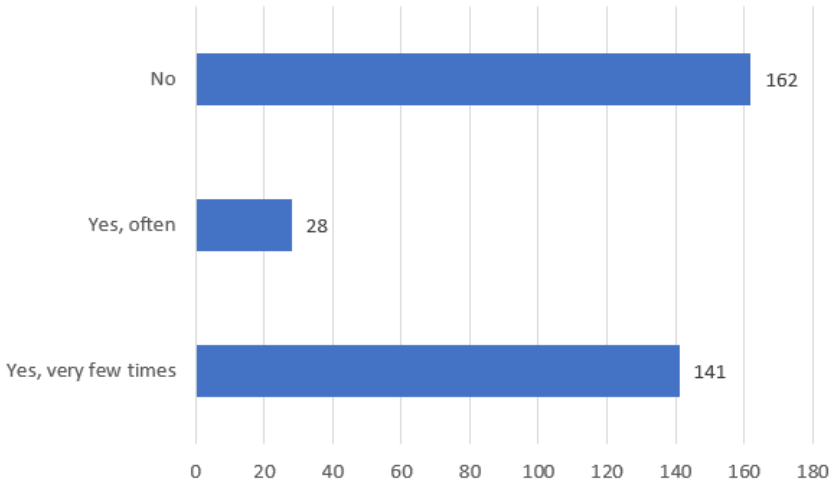


Table 37: Cheaters in online exams

3) *In DAD you taken:*

This question shows that the majority of respondents took only oral exams or predominantly oral exams during online exams. Probably because they are easier for teachers to implement

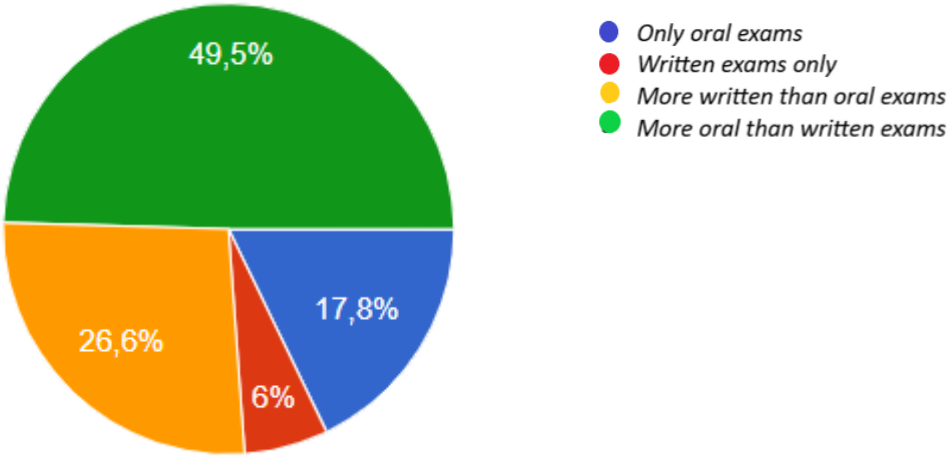


Figure 14: Exams during distance learning

4) What types of software has your university used to take online exams?

Exactly as with remote mode lectures, the most widely used software for online exams are:

- Microsoft Teams
- Zoom
- Google Meet

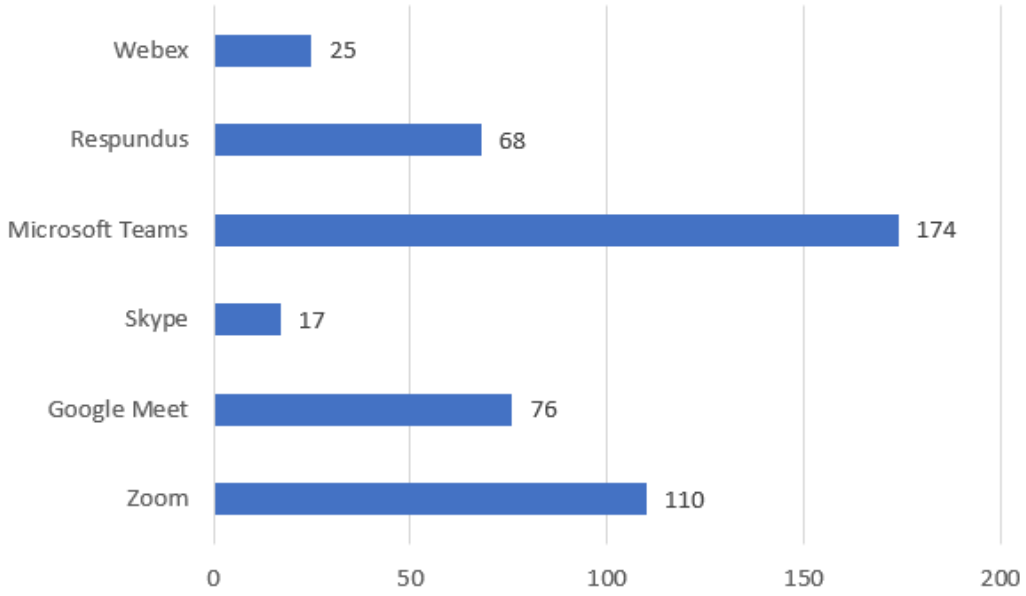


Table 38: Software used for online exams

5) Were proctoring tools used to monitor student activities during exams?

Only 30 percent of people said they routinely used proctoring tools during online exams.

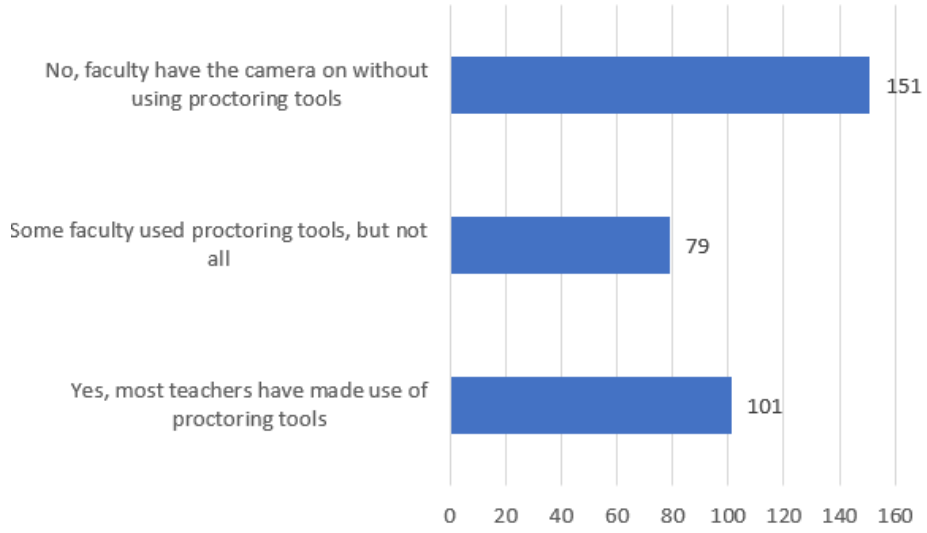


Table 39: Proctoring tools usage

6) *I believe that cheating during online exams is easier than in-person exams*
70% of respondents say it is easier to copy on online exams rather than in-person exams.

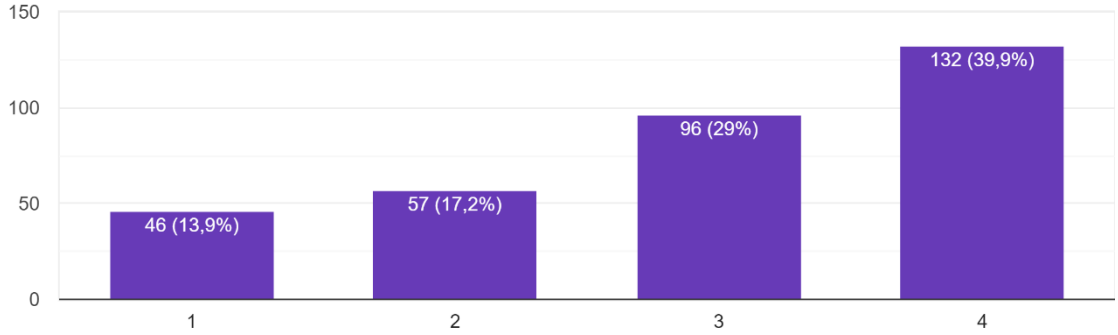


Table 40: Ease in cheating during online exams

7) Have you ever taken an online exam where the prof required the use of dual cameras (to get side control of the student)?

From this question, it can be seen that the use of dual cameras (which provide dual control of the student) is very little used in Italian universities.

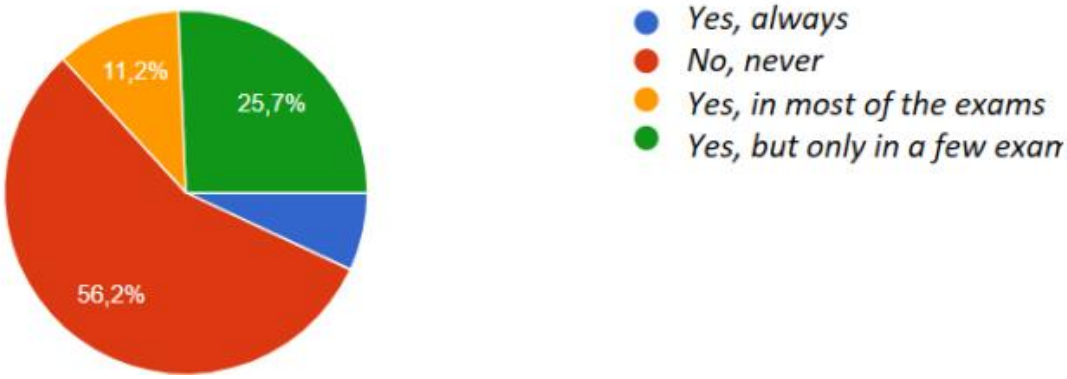


Figure 15: Dual camera usage

8) What do you think are the types of exams where it is easiest to cheat?

Without a shadow of a doubt, the answer to this question seems to be "written exams." This is probably given by the fact that written exams in remote mode do not allow for total control of the student. It is therefore easier to circumvent the rules and find ways to cheat.

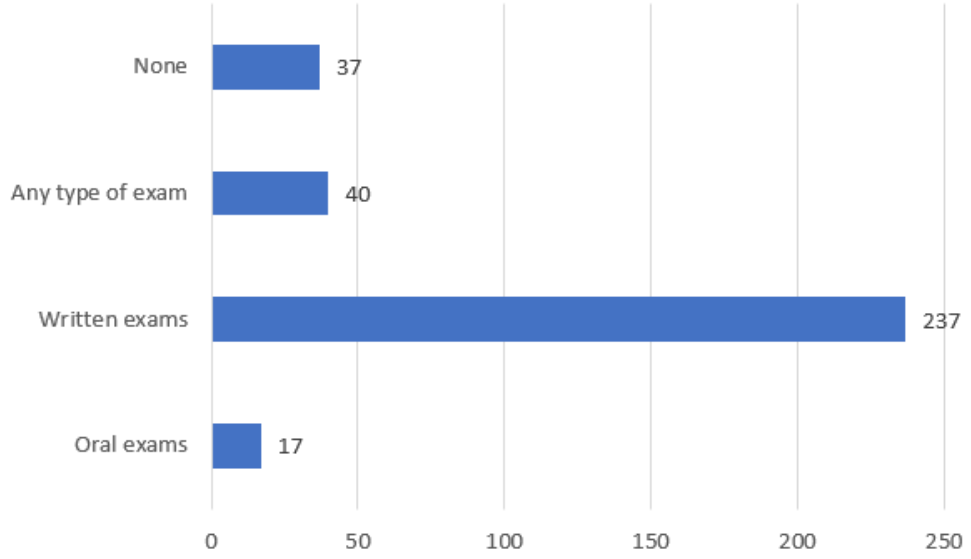


Table 41:Easiest exams for cheating

9) What is the easiest method to copy during an online ORAL exam?

Here we note that the easiest methods according to Italian students for copying during an online oral exam are two, and they were voted almost equal:

- *"Carpeting" the environment behind the pc (and the pc itself) with papers containing course material;*
- *Keep the course material in a document in your PC and open it next to the web page where the exam is open.*

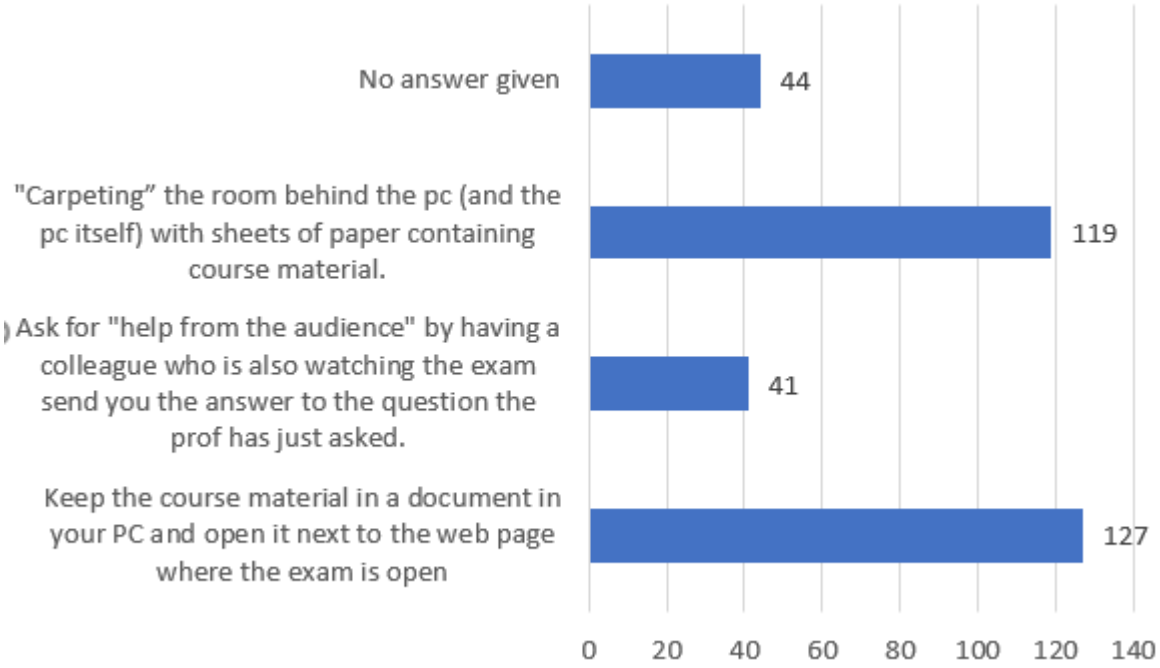


Table 42:Easiest methods to cheat during an online ORAL exam

10) What is the easiest method to copy during an online WRITTEN exam?

As for online written exams, which in question 8) proved to be the easiest to copy, there are as many as 3 highly rated methods:

- *"Carpeting" the environment behind the pc (and the pc itself) with papers containing course material*
- *Using a cell phone or tablet outside of the camera's viewing range*
- *"Conceal" sheets containing course notes among the materials allowed to take the exam*.

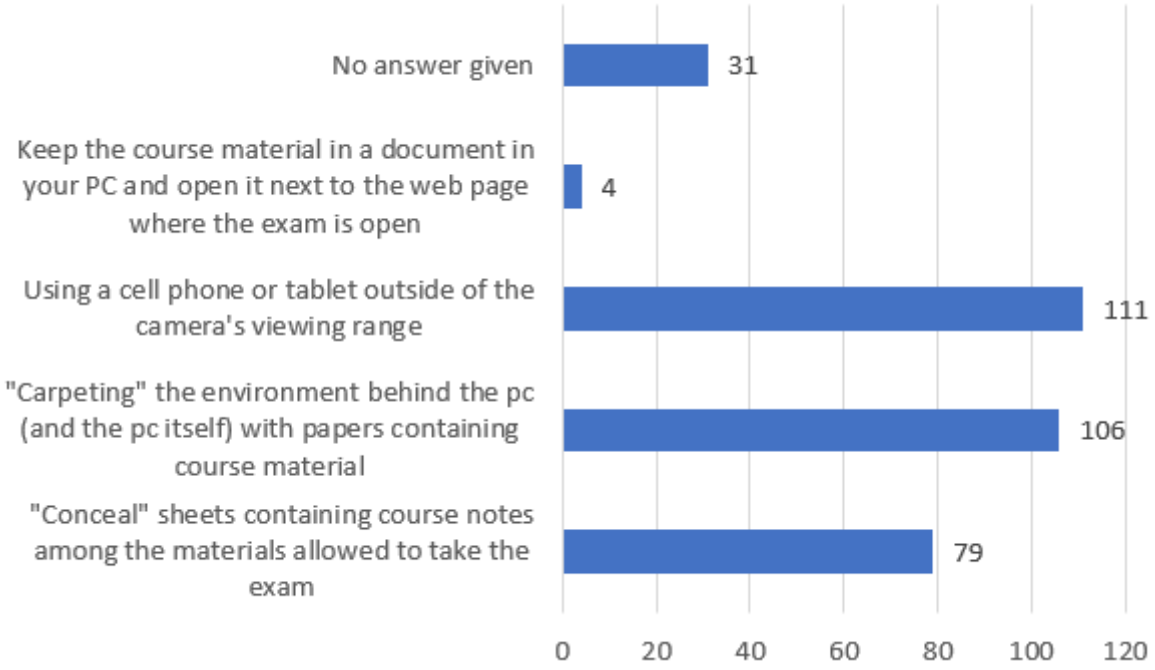


Table 43: Easiest methods to cheat during online WRITTEN exams

Chapter 4

Survey analysis - Statistics

4.1. Types of questions asked

The questionnaire that was administered to students has the following types of questions:

iii. Likert scales
iv. Purely qualitative questions
    a. Open questions
    b. Closed questions
    c. Semi-closed question: there is the possibility to add another answer in case the desired one is not present in the default list

It is important to highlight that Likert scales are question that asks the respondents how much they agree or disagree with the sentence proposed inside the question. This type of question is widely used to measure attitudes and opinions with a greater degree of possibility than a simple binary (yes/no) question. It is considered one of the most reliable ways to measure behaviors, opinions and perceptions. Likert scale uses a numeric scale in which each number corresponds to a specific level of agreement. [13]

In our case, Likert scales present 4 level of agreement. The respondent has to choose one of them for each Likert scale question.

More specifically, the levels of agreement are:

i. 1: Not agree at all
ii. 2: Do not really agree
iii. 3: Quite agree
iv. 4: Extremely agree

Therefore, as said in the lists above, there are three kinds of pure qualitative questions in the survey: open questions, closed questions and semi-closed questions.

They are aimed at learning about students' experiences during the pandemic and the pre-pandemic periods, the main problems they faced and their proposals to overcome them.

4.2. Tools used and purpose of the tests

This chapter aims to explain in detail each statistical test used to analyze the answers to the questions of the survey. As mentioned before, depending on the number of samples

[13] https://www.surveymonkey.com/mp/likert-scale/

analyzed for each question and the type of question itself, the statistics to be used to get an accurate result change, so it is important to emphasize well the purpose of each test.

In this thesis paper, all statistical calculations were performed using Microsoft Excel as a calculation tool. In many cases, the Excel extension "Data Analysis" was used, which allows for automatic calculation of the main statistical tests in an accurate and detailed manner.

The aim is to analyze the questions that were asked in Chapter 2, and this thesis would like to try to find an answer. For completeness they are re-attached below so as to be more usable for the reader:

i. The major differences from the pre-pandemic situation, from the perspective of students;
ii. The most effective teaching methods for students;
iii. The types of exams that allow for results that are not distorted by the possible copying methods that can be implemented by students during online sessions.

4.2.1. How have answers been analyzed?

The analyses conducted on the questionnaire were done differently depending on the type of question (Likert or pure qualitative) and depending on the number of samples examined at the same time.

The following will explain how the statistical tests were conducted and what assumptions were made.

4.2.1.1. Categories created

First of all, it is important to distinguish how the respondents to the survey questions were divided.

In order to have sample sizes that would allow comparisons to be made that had statistical significance, the respondents were divided into different categories:

- **FIXED** categories

  - Geographical category: Students from universities located in the North of Italy - Students from universities located in the Center of Italy - Students from universities located in the South of Italy

  - University Path category: Students from Scientific universities – Students from Humanistic universities

- University size category: Students from small (<15k students) - Medium (between 15k and 24.5k students) - Large (>40k students) universities

- **MOBILE** categories

  - Total category: Division of the collected responses according to what is needed to be analyzed at that time

The responses to the questions were divided among the various sections within the categories to clusters the respondents as much as possible. The purpose is to try to find similarities or differences within the various categories.

4.2.1.2. Answers analysis

The statistical tests used to analyze the responses to the survey are tests that are designed to be used on cardinal rather than ordinal scales.

The tests used (which will be described in detail in the following paragraphs) are in fact the following:

- T-test
- ANOVA
- Chi-squares for homogeneity
- Barlett's test
- Bonferroni post-hoc test

Moreover, in this thesis the alpha level is set to 0.05 and all date collected are supposed to be normally distributed.

The writer is aware that she has used tests for cardinal scales; however, it has been shown that, while not a perfectly rigorous approach, they are considered robust and effective for ordinal scales as well[14].

To be sure of having a meaningful result, where possible, some tests of proportions[15] were also conducted, which, although they provide a qualitatively lower result than the above tests, are a valuable aid in further confirming them since they are rigorous for the type of data analyzed.

Finally, the writer is also conscious of the existence of a relatively large literature of statistical tests for purely ordinal answers, which makes it possible not to have to

[14] https://statisticsbyjim.com/hypothesis-testing/analyze-likert-scale-data/

[15] https://saylordotorg.github.io/text_introductory-statistics/s13-04-comparison-of-two-population-p.html

approximate ordinal quantities to cardinal quantities. One of the main authors of this type of test is Emil Bashkansky, who is the inventor of the ORDANOVA[16], which is an ANOVA, but for ordinal scales. For future developments of this thesis, it might be interesting to try to replicate and expand the questionnaire using ORDANOVA as a statistical test.

4.2.1.2.1. Likert scales

All questions with Likert scales were analyzed using different statistical tests. The use of these varied depending on the number of clusters within the categories analyzed. Specifically, the following cases can be classified:

- In the case of categories with TWO clusters inside to be analyzed (e.g. Path category), a t-test (assuming equal variances) has been performed

- In the case of categories with THREE clusters inside (e.g. geographic cluster) to be analyzed at the same time the statistical test ANOVA (single factor) has been used.
    - Since the ANOVA has among its various assumptions that the variances of the samples should have no significant difference, another test has been conducted before every ANOVA test. The test involved is Barletts' test. To do it beforehand this website https://stattrek.com/online-calculator/bartletts-test.aspx;

    - When the ANOVA was founding significant difference between the category analyzed (p-value < 0.05), another test has been performed: the Bonferroni post-hoc test. It has the aim to understand which of the three subsamples differed from the others.

4.2.1.2.2. Qualitative questions

Even for purely qualitative questions, the type of statistical test used for analysis depends on the category being analyzed and thus the number of clusters within. Specifically, the following cases can be classified:

- In the case of categories with TWO clusters inside to be analyzed, the Chi-squared test of homogeneity has been used. This is to find out whether there is a significant difference in the distribution between two samples. In addition to the chi-squares test, the test for comparison of two population proportion was also conducted for this category of questions.

[16]https://scholar.google.com/citations?view_op=view_citation&hl=en&user=7OTtn9kAAAAJ&citation_for_view=7OTtn9kAAAAJ:qjMakFHDy7sC

- In the case of categories with THREE clusters inside to be analyzed, the Chi-squared test of homogeneity has been used.
    - When the chi-squared test of homogeneity was founding significant difference between the category analyzed (p-value < 0.05), other chi-square tests for homogeneity were conducted among the cluster pairs so as to identify which of the three differed from the others.

4.2.1.3. Statistical tests in details

Within the following subsections, the statistical tests used are explained in detail. The p-value was also calculated for all tests, the probability of obtaining the observed results, assuming that the null hypothesis is true.

4.2.1.3.1. T-Test

The t-test compares two means to find out if they are significantly different, and if so, how significant the difference is.

Types of t-tests are 3:

i. One sample t-test
ii. Two-sample t-test
iii. Paired t-test

The calculations are different for each of them and, in this thesis, one sample t-test and the two-sample t-test have been used.

One sample t-test

This type of t-test studies if the mean of data from one group differs from the pre-specified value.

For a valid test, data collected need to be:

- Independent (values are not related to one another);
- Continuous;
- Obtained via a simple random sample from the population;
- The population is assumed to be normally distributed

After checking the above points, it the t-test is considered appropriated, the null hypothesis H0 is set as follows:

H0: μ = prespecified value

The alternative hypothesis is that the underlying population mean is not equal to the prespecified value.

H1: μ ≠ prespecified value

To perform a one-sample t-test the average for the sample (x) need to be calculated and then the difference between the avarege for the sample and the prespecified value:

$$x - \mu$$

The standard error is calculated as

$$\frac{s}{\sqrt{n}}$$

Where the sample standard deviation is s and the sample size is n.

The test statistic uses the formula shown below[17]:

$$t = \frac{\overline{x} - \mu_0}{s/\sqrt{n}}$$

The test statistic is compared to a t value with the chosen alpha value (in our case is always 0.05) and the degrees of freedom involved in the test. The degrees of freedom (df) are based on the sample size and are calculated as[18]:

$$df=n-1$$

Two-sample t-test

This type of t-test studies if the means of two separate groups of data is significantly different from one another.

It is important to highlight that each of the 3 types of t-test has a different equation for calculating the t-statistic value. Below the formula for a two-sample t-test:

[17] https://www.leadquizzes.com/blog/how-to-use-t-test-calculator-guide/
[18] https://www.jmp.com/en_sg/statistics-knowledge-porta l/t-test/one-sample-t-test.html

$$t = \frac{\overline{X_1} - \overline{X_2}}{s_{x_1 x_2} \cdot \sqrt{\frac{1}{n1} + \frac{1}{n2}}}$$

Where:

- x1 is the mean value for the first sample
- x2 is the mean value for the second sample
- n1 is the sample size of the 1st sample
- n2 is the sample size of the 2nd sample
- sx1x2 is the standard deviation

The standard deviation (sx1x2) is calculated in the following way:

$$S_{X_1 X_2} = \sqrt{\frac{(n_1 - 1) S_{X_1}^2 + (n_2 - 1) S_{X_2}^2}{n_1 + n_2 - 2}}$$

Where:

- sx1 is the standard deviation for sample 1
- sx2 is the standard deviation for sample 2

For what regards the degrees of freedom, in order to calculate them, it is necessary to subtract 1 from the total number of items in the sample.

Since we are talking about a two-sample t-test, the formula to calculate the degrees of freedom is slightly different (this is due to the fact that in case of 2 sample t-test there are two samples instead of one). Here it is:

$$df = n1 + n2 - 2$$

If the t-statistic obtained is greater than the critical value that is it possible to find in the t-distribution table for that specific alpha level and degrees of freedom, the statistical difference can be considered significant and the null hypothesis is rejected.[19]

Paired t-test

For the sake of completeness, the paired t-test is used to check answers of one group of people that answered twice the same survey. This type of t-test can show if the mean has changed significantly between the first and second time they took the survey.

[19] https://www.leadquizzes.com/blog/how-to-use-t-test-calculator-guide/

In this thesis, the paired t-test is not used.

4.2.1.3.2. ANOVA

One-way ANOVA is used in this thesis. A one way ANOVA is used to compare two or more means from two independent (unrelated) groups.

ANOVA compares these group means to find out if they are statistically different or if they are similar. The outcome of ANOVA is the "F statistic". The F statistic is a ratio that shows the difference between the within group variance and the between group variance. This ratio is an outcome that allows a conclusion that the null hypothesis is supported or rejected. If there is a significant difference between the groups, the null hypothesis is not supported, and the F-ratio will be larger.

To perform a one-way ANOVA it is necessary to select an independent variable (the item being measured that you want to prove it is affected by the independent variables) and a non-fixed number of independent variables (the items being measured that may have an effect on the dependent variable)

After that, it is necessary to introduce the null hypothesis H0 and the alternative hypothesis H1. Depending on the result of the ANOVA test, the null hypothesis will either be accepted or rejected.

The one-way ANOVA assumptions are the following:

- **Independence**: The value of the dependent variable for one observation is independent of the value of any other observations

- **Normalcy**: The value of the dependent variable is normally distributed

- **Variance**: There is no significant difference among groups variances. In order to ensure this assumption, the Barlett's test has been conducted before every ANOVA test.

- **Continuous**: The dependent variable is continuous

It is important to highlight that the one-way ANOVA tells that at least two groups were different from each other. But it won't tell which is the different group. If the test returns a significant f-statistic, to understand in which sample the difference is, it is necessary a post-hoc test (like the Bonferroni post-hoc test).[20]

[20] https://www.statisticshowto.com/probability-and-statistics/hypothesis-testing/anova/

4.2.1.3.3. Barlett's test

Bartlett's test is used to test if two or more samples have equal variances, so if there is homogeneity of variances. The writer did that because the ANOVA needs equal variances, so before every ANOVA test, the Barlett's test has been conducted. Bartlett's test is always useful when the assumption of equal variances is made.[21]

The Bartlett test is defined as:

H_0: $\sigma_{12} = \sigma_{22} = ... = \sigma_{k2}$

H_a: $\sigma_{i2} \neq \sigma_{j2}$ for at least one pair (i,j)

As said before, the Bartlett test checks the equality of variances across groups against the alternative that variances are unequal for at least two groups.

$$\chi^2 = \frac{(N-k)\ln(S_p^2) - \sum_{i=1}^{k}(n_i - 1)\ln(S_i^2)}{1 + \frac{1}{3(k-1)}\left(\sum_{i=1}^{k}\left(\frac{1}{n_i - 1}\right) - \frac{1}{N-k}\right)}$$

In the above:

- s_i^2 is the variance of the i^{th} group;
- N is the total sample size;
- N_i is the sample size of the i^{th} group;
- k is the number of groups;
- s_p^2 is the pooled variance.

Significance Level: α

The variances are judged to be unequal if,

$\chi > \chi^2_{1-\alpha,k-1}$

where $\chi^2_{1-\alpha,k-1}$ is the critical value of the chi-square distribution with k - 1 degrees of freedom and a significance level of α.

4.2.1.3.4. Bonferroni post-hoc test

Bonferroni correction is a method used to control the family-wise error rate. The family-wise error rate is the probability of incorrectly rejecting the true null hypothesis (the chance of finding a false positive result – type I error). The Family-wise error rate (FWER) is calculated as follows:

$$FWER = 1 - (1 - \alpha)^m$$

[21] https://www.itl.nist.gov/div898/handbook/eda/section3/eda357.htm

Where m is the number of tests, in our case m is always 3. Calculating the FWER, the writer accepts that there is a certain chance percentage of obtaining a false positive result.

When the P value calculated with the ANOVA test is lower that the alpha level, the Bonferroni post-hoc correction is needed to see where the group differences are.

Indeed, in this case it is necessary to study the results comparing the three groups in each possible comparison, so three individual tests are needed. It is easy to note that the FWER is this case is:

$$FWER = 1 - (1 - 0.05)^3 = 0.1426$$

Just by doing 3 tests, there is a 14.26% chance of discovering one or more false-positive results. The more tests that are performed, the larger the family-wise error rate is. To account for this error, a multiple comparisons correction method is needed. The writer chose the Bonferroni post-hoc test because of its ease to use ans understand, it is indeed commonly used. The alpha level is corrected in the following way:

$$Bonferroni - corrected\ \alpha = \frac{\alpha}{m}$$

Where α is the original α and m is the number of tests.

This will mean that in our case the Bonferroni – corrected α is:

$$Bonferroni - corrected\ \alpha = \frac{0.05}{3} = 0.01667$$

So the FWER changes as follows:

$$FWER = 1 - (1 - 0.01667)^3 = 0.04918$$

The FWER is 4.91%. By correcting the alpha level though the Bonferroni method, we have reduced the FWER back down to around 5%. The main advantage of Bonferroni correction method is that it keeps the FWER level around 5% regardless the number of simultaneous tests.

Using the Bonferroni corrected alpha the results to be statistically significant the P value has to be less than the “new” alpha, so 0.008.[22]

4.2.1.3.5. Chi-squares for homogeneity

The Chi-squares for homogeneity test is a method, based on the chi-square statistic, that tests whether two or more distributions are equal.
In order to formalize the hypothesis that all the clusters involved in the test are distributed equally among the categorizations listed in the test, it is necessary to test the following hypotheses, please pay attention to the notation used:

[22] https://www.youtube.com/watch?v=HLzS5wPqWR0

- i = A, B = samples present in the test
  - A = first sample
  - B = second sample

- J = X, Y, Z = categorizations present in the test
  - X = first categorization
  - Y = second categorization
  - Z = third categorization

$$H0: pAX = pBX \text{ and } pAY = pBY \text{ and } pAZ = pBZ$$

$$H1: pAX \neq pBX \text{ and } pAY \neq pBY \text{ and } pAZ \neq pBZ$$

- pAj is the proportion of people of the first sample that belongs to the categorization j = X, Y, Z

- pBj is the proportion of people of the second sample that belongs to the categorization j = X, Y, Z

To perform the test is necessary to put all data into a table. The table has the following characteristics:

- The letter i will index the h rows. They contains the samples
- The letter j will index the k columns. They contains the categorizations

Chi-squares for homogeneity		J			
		Categorization X	Categorization Y	Categorization Z	(FIXED) TOTAL
i	Sample A	y_{11} (p_{11})	y_{12} (p_{12})	y_{13} (p_{13})	$n_1 = \Sigma\ y_{1j}$
	Sample B	y_{21} (p_{21})	y_{22} (p_{22})	y_{23} (p_{23})	$n_2 = \Sigma\ y_{2j}$
	TOTAL	$y_{11} + y_{21}$ (p_1)	$y_{12} + y_{22}$ (p_2)	$y_{13} + y_{23}$ (p_3)	$n_1 + n_2$

Table 44: Chi-squares for homogeneity - how it works

Considering the following notation:

- y_{ij}: the number that falls into the j^{th} categorization of the i^{th} sample

- $p_{ij} = y_{ij}/n_i$: the proportion in the i^{th} sample falling into the j^{th} categorization

- $n_i = \Sigma\, y_{ij}$: denoting the total number in the i^{th} sample
- $p_j = (y_{1j} + y_{2j}) / (n_1 + n_2)$: the (overall) proportion falling into the j^{th} categorization

The chi-square test statistic for testing the equality of two or more multinomial distributions is[23]:

$$Q = \sum_{i=1}^{h} \sum_{j=1}^{k} \frac{(y_{ij} - n_i \hat{p}_j)^2}{n_i \hat{p}_j}$$

follows an approximate chi-square distribution with (k−1)*(h-1) degrees of freedom.

The null hypothesis of equal proportions must be rejected if Q is large, that is, if:

$$Q \geq \chi^2_{\alpha, (k-1)(h-1)}$$

4.2.1.3.6. Comparison of two population proportion

The comparison of two population proportion provides information in the samples to estimate the difference p1−p2 in the two population proportions. Each population is divided into two groups, the group of elements that have the characteristic of interest and the group of elements that do not.

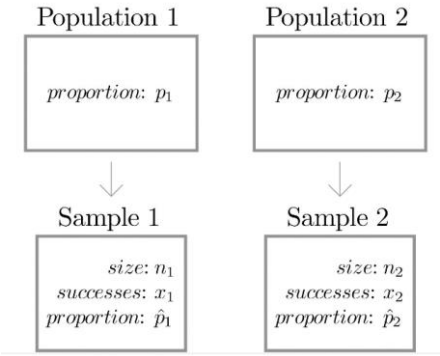


Figure 16: Elements needed for the comparison of two population proportion

The populations are labeled as Population 1 and the other as Population 2, and the proportion of each population that possesses the characteristic analyzed is labeled with the number 1 (for population 1) and number 2 (for population 2). After that, two sample (one for population 1 and one for population 2) are collected. The sample must be without reference from each other. So, as said above, the objective is using the information in

[23] https://online.stat.psu.edu/stat415/lesson/17/17.1

the *samples* to estimate the difference p1−p2 in the two *population* proportions and to make statistically valid inferences about it.

In hypothesis tests concerning the relative sizes of the proportions p1 and p2 of two populations that possess a particular characteristic, the null and alternative hypotheses will always be expressed in terms of the difference of the two population proportions. So, the null hypothesis is written as follows:

$$H_0: p_1 - p_2 = D_0$$

The alternative hypothesis, will be:

$$H_0: p_1 - p_2 \neq D_0$$

If the samples are independent and both are sufficiently large the following formula for the standardized test statistic is valid, and it has the standard normal distribution.

$$Z = \frac{(\hat{p}_1 - \hat{p}_2) - D_0}{\sqrt{\frac{\hat{p}_1(1-\hat{p}_1)}{n_1} + \frac{\hat{p}_2(1-\hat{p}_2)}{n_2}}}$$

To accept the null hypothesis the Z statistics needs to fall into the acceptance region. In the case of this thesis the acceptance region is always (-1,96, +1,96) since the alpha is 0,05 and the tests are two tailed tests.

Chapter 5

Questions analysis - Hypothesis and tests

5.1.Chapter purpose

The purpose of this chapter, which is the main chapter of the thesis, is to draw results from what the questionnaire gave us to see. Then, hypotheses will be posed, which will be disproved or approved by the statistical tests that were explained in the previous chapter.

It is important to note that the hypotheses are based on the bullets listed in chapter two:

i. The major differences from the pre-pandemic situation, from the perspective of students;
ii. The most effective teaching methods for students;
iii. The types of exams that allow for results that are not distorted by the possible copying methods that can be implemented by students during online sessions.

Indeed, the hypotheses are aimed at trying to give answers to these questions.

5.2.Major differences from the pre-pandemic situation

The main topic that will be covered in this paragraph is the point i. of the previous list: what are the main differences from the pre-pandemic situation, using the students point of view?

As mentioned in previous chapters, certainly the change has been radical and has brought with it new routines, new ways of approaching teaching and everything else. But what are the features of distance education that have caught the attention of students the most?

5.2.1. Quality of online education

The first point the writer wants to analyze is the issue of the **quality of online education**. The first question for pursuing the analysis of the differences between traditional and online teaching is to understand whether there is a substantial difference that students perceive in the quality of courses. Note that the question that was asked is about the general feeling that students have about the quality of distance education. In fact, the question is intended to test whether students' common thinking sees online teaching as a lower quality tool than in-person teaching.

Surely one of the biggest concerns for faculty is to be able to ensure online classes that are qualitatively comparable to in-person classes. For this reason, students were asked the following question (which had to be answered via a Likert scale):

After taking classes in distance learning, I feel less ready for exams than when I took in-person (pre-pandemic).

As we saw earlier, about 70% of respondents disagreed with the statement. It is a very high percentage indicating that almost 3/4 of the respondents have the same opinion about it. Nonetheless, it is interesting to see whether among the various fixed categories we can claim to notice any substantial differences.

To conduct tests on the various categories of students, the steps are as follows:

- set the null hypothesis and the alternative hypothesis;
- conduct the right test depending on the number of clusters within the category and the type of question.

From now on, all questions answered with a Likert scale will be analyzed following this pattern.

So, going back to the question above in bold, let's start analyzing the ***University Path Category***. In this case, I do not expect a significant difference between the clusters in the University path category. Let us analyze to see if this is indeed the case.

Given that:

- the question is a Likert scale;
- the category in question contains two clusters of students (students attending a science-based degree program and students attending a humanities-based degree program)

The appropriate statistical test for the purpose is the t-test. Below the null hypothesis and the alternative hypothesis that were set for the test.

University Path Category	
H0	H1
There is NO difference in Likert scale mean between students that attend scientific path and students that attend humanistic path	There is a difference in Likert scale mean between students that attend scientific path and students that attend humanistic path

Table 45: H0 and H1 for University path category – Quality of online education

In the graph below it is possible to see the results of the responses divided between the two clusters.

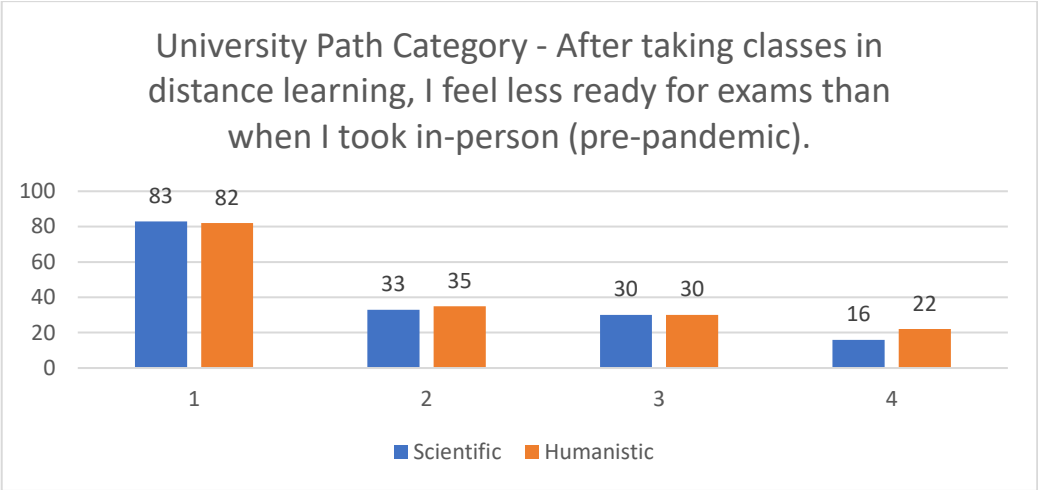


Table 46: Results for University path category - Quality of online education

It is immediate to note from the graph that the proportions of responses between the two clusters are really very similar.

Using the excel tool, the following information about the t-test conducted can be obtained:

University Path Category				
Scientific - Humanistic	t-Test: Two-Sample Assuming Equal Variances			
		Scientific	*Humanistic*	
	Mean	1,87	1,95	
	Variance	1,08	1,19	
	Observations	162,00	169,00	
	Pooled Variance	1,14		
	Hypothesized Mean Difference	0,00		
	df	329,00		
	t Stat	-0,70		
	P(T<=t) one-tail	0,24		
	t Critical one-tail	1,65		
	P(T<=t) two-tail	0,48		> 0,05
	t Critical two-tail	1,97		

Table 47: t-test - Quality of online education for University path category

It is possible to see that the averages between the two clusters are very similar. By performing the test, the p-value two tail is indeed found to be greater than alpha (0.05), therefore, the null hypothesis cannot be rejected.

Therefore, we can conclude that among scientific path students and humanistic path students, no substantial difference was found between the Likert scale responses to the statement "After taking classes in distance learning, I feel less ready for exams than when I took in-person (pre-pandemic)".

In general, it is possible to see that the average of the responses is around 2, so "Do not really agree." for both clusters.

At this point it is possible to continue the analysis with the ***Geographical category***.

Again, I do not expect significant differences, as I assume that distance learning was able to adequately educate all Italian students during the pandemic period despite the difficulties.

Given that:

- the question is a Likert scale;
- the category in question contains three clusters of students (Students from universities located in the North of Italy - Students from universities located in the Center of Italy - Students from universities located in the South of Italy)

The appropriate statistical test for the purpose is the ANOVA test. Before conducting the ANOVA test, it is necessary to understand whether or not there is a significant difference between the variances of the three clusters. Therefore, the Barlett's test can be found below.

The null hypothesis and the alternative hypothesis are the following:

Geographical Category	
H0	H1
Variance is equal across all groups	Variance is NOT equal across all groups

Table 48: H0 and H1 for Geographical category – Barlett's test – Quality of online education

Using the Barlett's test calculator mentioned in the previous chapter, the outcome is in the image below. Please take into account that Group 1 is North, Group 2 is Center, Group 3 is South. Moreover, the variances of the clusters were calculated using MS Excel's "var.s" formula.

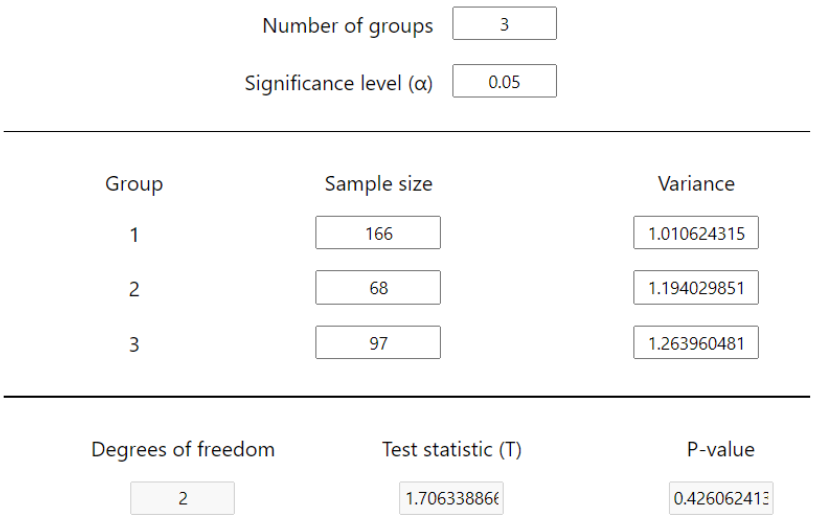


Figure 17: Barlett's test output

Since the p-value is bigger than the significance level, the null hypothesis of equal variance is accepted.

Now it is possible to conduct the ANOVA test.

Below the null hypothesis and the alternative hypothesis that were set for the test.

Geographical Category	
H0	H1
There is NO difference in Likert scale mean between the three groups (people that study in universities located in the North of Italy vs South vs Center)	There is a difference in Likert scale mean between the three groups (people that study in universities located in the North of Italy vs South vs Center)

Table 49: H0 and H1 for Geographical category – Quality of online education

In the graph below it is possible to see the results of the responses divided between the three clusters.

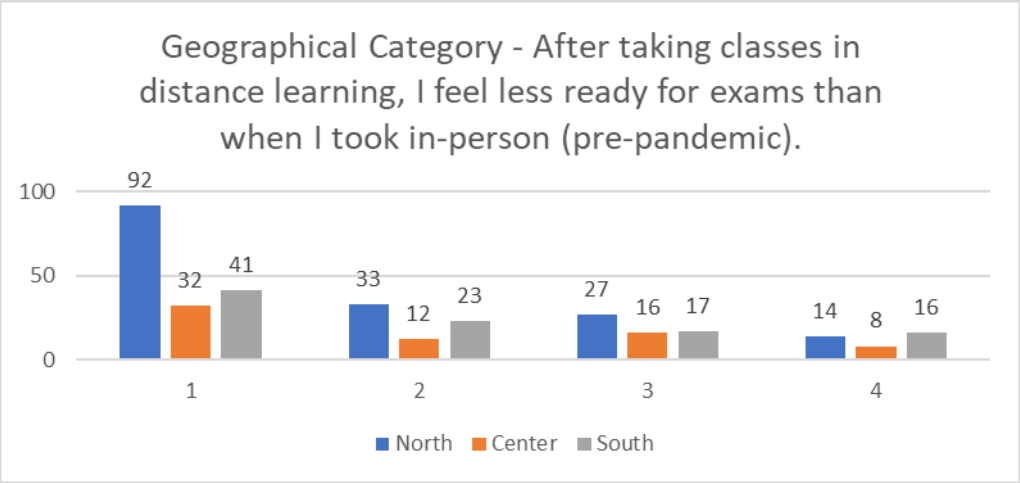


Table 50: Results for Geographical category - Quality of online education

Again, the proportions among the various clusters are very similar. Using the excel tool, the following information about the ANOVA test conducted can be obtained:

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
NORTH	166	295	1,78	1,01
CENTER	68	136	2	1,19
SOUTH	97	202	2,08	1,26

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	6,37	2,00	3,18	2,84	0,06	3,02
Within Groups	368,09	328,00	1,12			

Table 51: ANOVA Single Factor - Quality of online education for Geographical category

By performing the test, the p-value is indeed found to be greater than alpha (0.05), therefore, the null hypothesis cannot be rejected.

Therefore, we can conclude that among the Geographical Category, no substantial difference was found between the Likert scale responses to the statement " After taking classes in distance learning, I feel less ready for exams than when I took in-person (pre-pandemic)".

In general, it is possible to see that the average of the responses is around 2, so "Do not really agree." for all clusters.

To conclude the analysis, it is necessary to test the ***University Size Category***.

As with the analysis of the previous categories, I do not expect significant differences here.

Given that, as per the Geographical Category:

- the question is a Likert scale;
- the category in question contains three clusters of students (Students from small (<15k students) - Medium (between 15k and 24.5k students) - Large (>40k students) universities)

The appropriate statistical test for the purpose is the ANOVA test. Before conducting the ANOVA test, it is necessary to understand whether there is a significant difference between the variances of the three clusters. Therefore, the Barlett's test can be found below.

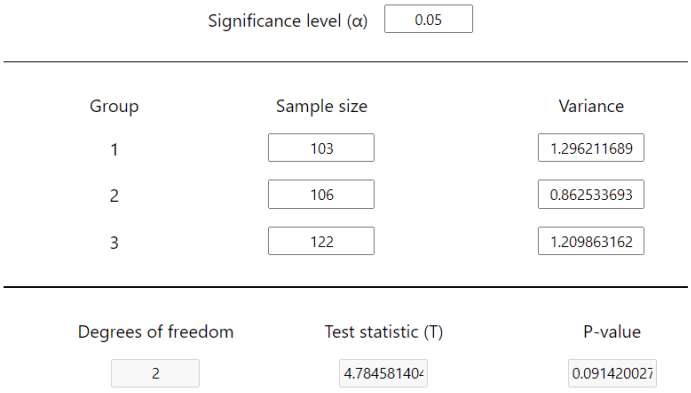
The null hypothesis and the alternative hypothesis are the following:

University Size Category	
H0	H1
Variance is equal across all groups	Variance is NOT equal across all groups

Table 52:H0 and H1 for Univeristy size category – Barlett's test – Quality of online education

Using the Barlett's test calculator mentioned in the previous chapter, the outcome is in the image below.

Figure 18: Barlett's test output



Please take into account that Group 1 is Small universities, Group 2 isMedium universities, Group 3 is Large universities. Moreover, the variances of the clusters were calculated using MS Excel's "var.s" formula.

Since the p-value is bigger than the significance level, the null hypothesis of equal variance is accepted.

Now it is possible to conduct the ANOVA test.

Below the null hypothesis and the alternative hypothesis that were set for the test.

University Size Category	
H0	H1
There is NO difference in Likert scale mean between the three groups (people that study in small universities vs medium vs large)	There is a difference in Likert scale mean between the three groups (people that study in small universities vs medium vs large)

Table 53: H0 and H1 for University size category – Quality of online education

In the graph below it is possible to see the results of the responses divided between the three clusters.

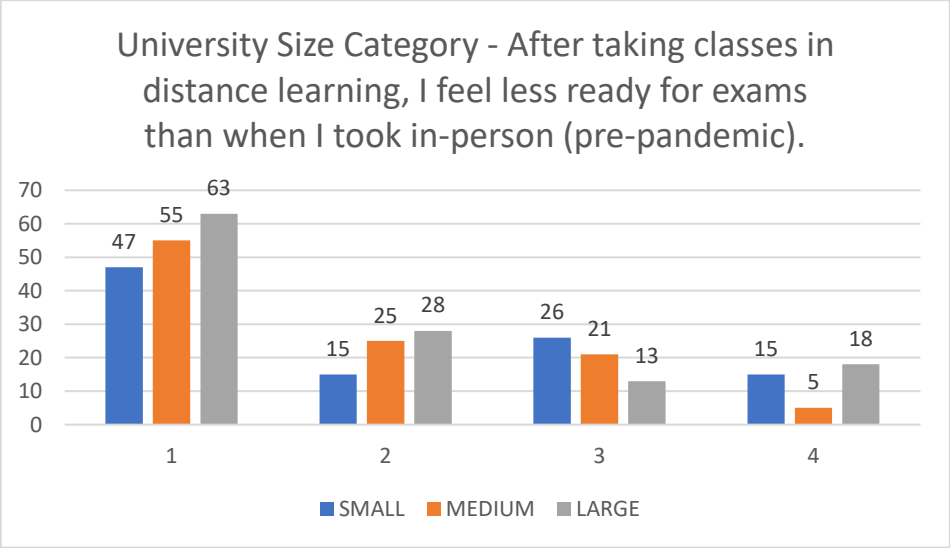


Table 54: Results for University size category - Quality of online education

Using the excel tool, the following information about the ANOVA test conducted can be obtained:

Anova: Single Factor						
SUMMARY						
Groups	*Count*	*Sum*	*Average*	*Variance*		
SMALL	103	215	2,09	1,30		
MEDIUM	106	188	1,77	0,86		
LARGE	122	230	1,89	1,21		
ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	5,29	2,00	2,64	2,35	0,10	3,02
Within Groups	369,17	328,00	1,13			
Total	374,46	330,00				

Table 55: ANOVA Single factor - Quality of online education for University size category

By performing the test, the p-value is found to be greater than alpha (0.05), therefore, the null hypothesis cannot be rejected.

Therefore, we can conclude that among the University Size Category, no substantial difference was found between the Likert scale responses to the statement " After taking classes in distance learning, I feel less ready for exams than when I took in-person (pre-pandemic)".

In general, it is possible to see that the average of the responses is around 2, so "Do not really agree." for all clusters.

As could be seen in the analysis of the " After taking classes in distance learning, I feel less ready for exams than when I took in-person (pre-pandemic)" statement, in all three categories analyzed (University Path Category, Geographical Category, University Size Category) there were no significant differences between the clusters.

The mean response for all clusters always approximated 2 - Do not really agree.

Below the graph with all the answers:

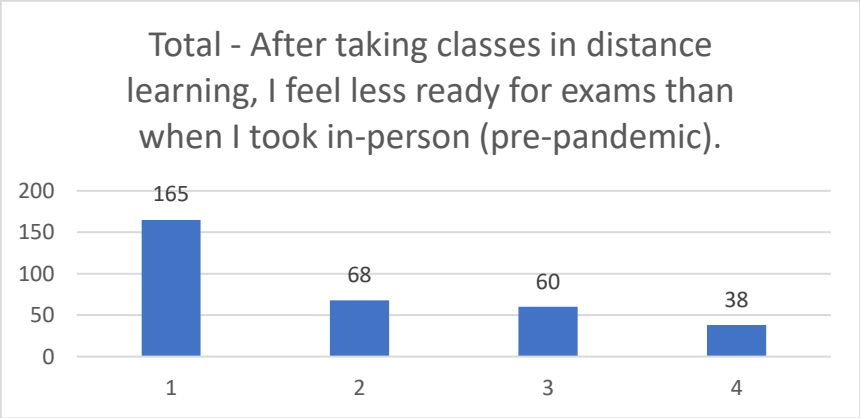


Table 56: Results for the Total Category - Quality of online education

We can conclude by saying that the collective sentiment of Italian students is that online lectures succeed in giving no less preparation for exams than in-person lectures.

Conducting the one sample t-test on all respondents to the survey, we set the following hypotheses (null and alternative):

Total Category	
H0	H1
There is NO significant difference between the values of the sample, compared with the value 2 – Do not really agree	There is a significant difference between the values of the sample, compared with the value 2 – Do not really agree

Table 57: H0 and H1 for Total category – Quality of online education

Calculating through MS Excel the one sample t-test - two-tailed analysis, the outcome is the following:

ONE SAMPLE T TEST	
Mean	1,91
Standard deviation	1,07
Count	331,00
Standard error of mean	0,06
Degrees of freedom	330,00
Hypotized mean	2,00
t-statistic	1,50
p-value	0,14

Table 58: One sample t-test - Total category - Quality of online education

The p-value is 0.14 and the alpha level is set at 0.05, so the p-value is grater the alpha level. I cannot reject the null hypothesis.

5.2.2. Ease in keeping up with classes during distance learning

The second point that the writer believes should be analyzed, after seeing that on average for students (the type of lecture (online or in-person) does not affect exam preparation), is whether students are able to keep up more with online or in-person lectures.

It is well known that students very often tend to accumulate the topics of various exams and find themselves rushing to study everything in a short period of time, which is not without repercussions on their quality of life.

Has distance learning proven to be a method for students to stay more on top of classes and not have to find themselves having to study everything at the last minute?

To understand this, it is necessary to conduct the analysis on the following statement (which had to be answered via a Likert scale):

"By taking the courses in distance learning I am able to keep up with the lessons of the courses more than when I was taking in-person (pre-pandemic)"

In this case, as we could see in Chapter 3, about 65% of the respondents agreed with the statement. Also in this case it is a very high percentage. It is interesting to see whether among the various fixed categories we can claim to notice any substantial differences.

Again, I do not expect significant differences among the clusters in the various categories. But let's analyze in detail to be sure:

Starting from the ***University Path Category,*** we know it has the following characteristics:

- the question is a Likert scale;
- the category in question contains two clusters of students (students attending a science-based degree program and students attending a humanities-based degree program)

The appropriate statistical test for the purpose is the t-test. Below the null hypothesis and the alternative hypothesis that were set for the test.

University Path Category	
H0	H1
There is NO difference in Likert scale mean between students that attend scientific path and students that attend humanistic path	There is a difference in Likert scale mean between students that attend scientific path and students that attend humanistic path

Table 59: H0 and H1 for University path category – Ease in keeping up with classes

In the graph below it is possible to see the results of the responses divided between the two clusters.

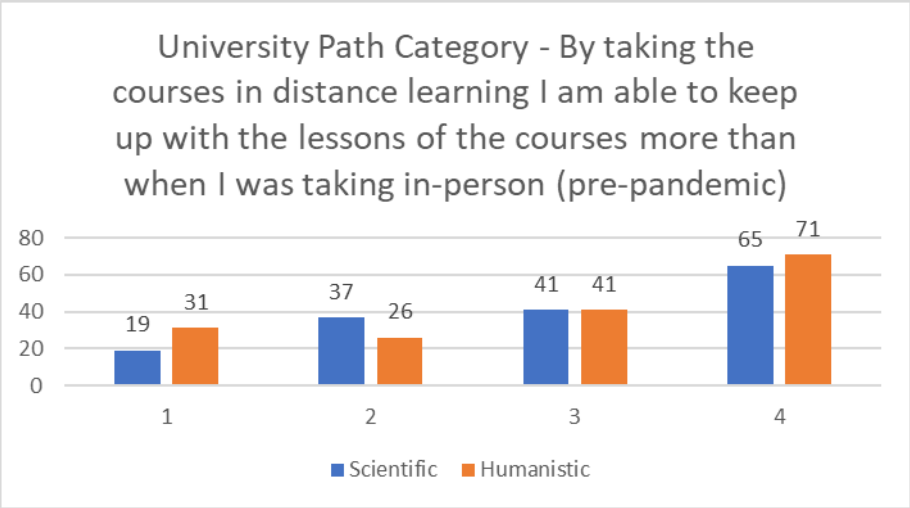


Table 60: Results for University path category - Ease in keeping up with classes

Using the Excel tool, the following information about the t-test conducted can be obtained:

University Path Category				
Scientific - Humanistic	t-Test: Two-Sample Assuming Equal Variances			
		Scientific	*Humanistic*	
	Mean	2,90	2,94	
	Variance	1,31	1,10	
	Observations	169,00	162,00	
	Pooled Variance	1,21		
	Hypothesized Mean Difference	0,00		
	df	329,00		
	t Stat	-0,32		
	P(T<=t) one-tail	0,37		
	t Critical one-tail	1,65		
	P(T<=t) two-tail	0,75		> 0,05
	t Critical two-tail	1,97		

Table 61: t-test - Ease in keeping up with classes for University path category

It is possible to see that the averages between the two clusters are very similar. By performing the test, the p-value two tail is indeed found to be greater than alpha (0.05), therefore, the null hypothesis cannot be rejected.

Therefore, we can conclude that among scientific path students and humanistic path students, no substantial difference was found between the Likert scale responses to the statement " By taking the courses in distance learning I am able to keep up with the lessons of the courses more than when I was taking in-person (pre-pandemic)".

In general, it is possible to see that the average of the responses is around 3, so "Quite Agree" for both clusters.

At this point it is possible to continue the analysis with the ***Geographical category***.

Given that:

- the question is a Likert scale;
- the category in question contains three clusters of students (Students from universities located in the North of Italy - Students from universities located in the Center of Italy - Students from universities located in the South of Italy)

The appropriate statistical test for the purpose is the ANOVA test. Before conducting the ANOVA test, it is necessary to understand whether or not there is a significant difference between the variances of the three clusters. Therefore, the Barlett's test can be found below. The null hypotesis and the alternative hypotesis are the following:

Geographical Category	
H0	H1
Variance is equal across all groups	Variance is NOT equal across all groups

Table 62: H0 and H1 for Geographical category – Barlett's test - Ease in keeping up with classes

Using the Barlett's test calculator mentioned in the previous chapter, the outcome is in the image below. Please take into account that Group 1 is North, Group 2 is Center, Group 3 is South. Moreover, the variances of the clusters were calculated using MS Excel's "var.s" formula.

Number of groups	3
Significance level (α)	0.05

Group	Sample size	Variance
1	166	1.199890471
2	68	1.221027217
3	97	1.216065292

Degrees of freedom	Test statistic (T)	P-value
2	0.00959780€	0.995212593

Table 63:Barlett's test output - Ease in keeping up with classes for Geographical category

Since the P-value is bigger than the significance level, the null hypothesis of equal variance is accepted.

Now it is possible to conduct the ANOVA test.

Below the null hypothesis and the alternative hypothesis that were set for the test.

Geographical Category	
H0	H1
There is NO difference in Likert scale mean between the three groups (people that study in universities located in the North of Italy vs South vs Center)	There is a difference in Likert scale mean between the three groups (people that study in universities located in the North of Italy vs South vs Center)

Table 64: H0 and H1 for Geographical category – Ease in keeping up with classes

In the graph below it is possible to see the results of the responses divided between the three clusters.

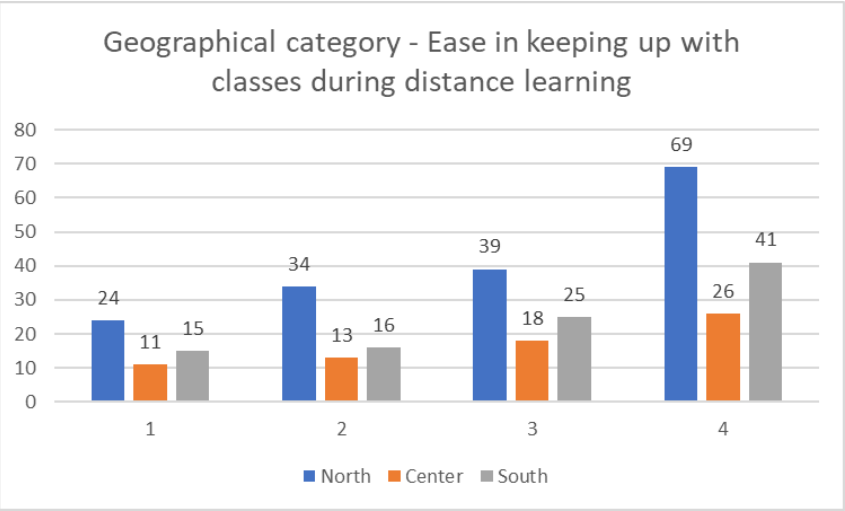


Table 65: Results for Geographical category - Ease in keeping up with classes

Using the excel tool, the following information about the ANOVA test conducted can be obtained:

Anova: Single Factor						
SUMMARY						
Groups	*Count*	*Sum*	*Average*	*Variance*		
NORTH	166	485	2,92	1,20		
CENTER	68	195	2,87	1,22		
SOUTH	97	286	2,95	1,22		
ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0,3	2	0,13	0,11	0,90	3,02
Within Groups	396,5	328	1,21			
Total	396,8	330				

Table 66: ANOVA Single factor - Ease in keeping up with classes for Geographical category

By performing the test, the p-value is indeed found to be greater than alpha (0.05), therefore, the null hypothesis can not be rejected.

Therefore, we can conclude that among the Geographical Category, no substantial difference was found between the Likert scale responses to the statement " After taking classes in distance learning, I feel less ready for exams than when I took in-person (pre-pandemic)".

In general, it is possible to see that the average of the responses is around 3, so "Quite agree." for all clusters.

To conclude the analysis it is necessary to test the ***University Size Category***.

Given that, as per the Geographical Category:

- the question is a Likert scale;
- the category in question contains three clusters of students (Students from small (<15k students) - Medium (between 15k and 24.5k students) - Large (>40k students) universities)

The appropriate statistical test for the purpose is the ANOVA test. Before conducting the ANOVA test, it is necessary to understand whether there is a significant difference between the variances of the three clusters. Therefore, the Barlett's test can be found below.

The null hypothesis and the alternative hypothesis are the following:

University Size Category	
H0	H1
Variance is equal across all groups	Variance is NOT equal across all groups

Table 67: H0 and H1 for University size category – Ease in keeping up with classes

Using the Barlett's test calculator mentioned in the previous chapter, the outcome is in the image below. Please take into account that Group 1 is Small universities, Group 2 is Medium universities, Group 3 is Large universities. Moreover, the variances of the clusters were calculated using MS Excel's "var.s" formula.

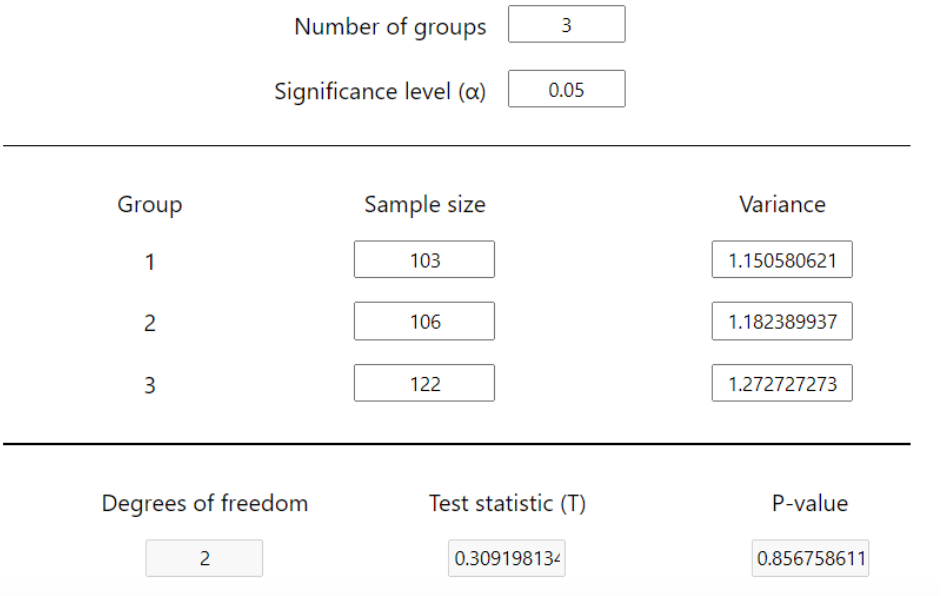


Table 68: Barlett's test output - Ease in keeping up with classes for University size category

Since the P-value is bigger than the significance level, the null hypothesis of equal variance is accepted.

Now it is possible to conduct the ANOVA test.

Below the null hypothesis and the alternative hypothesis that were set for the test.

University Size Category	
H0	H1
There is NO difference in Likert scale mean between the three groups (people that study in small universities vs medium vs large)	There is a difference in Likert scale mean between the three groups (people that study in small universities vs medium vs large)

Table 69: H0 and H1 for University size category – Ease in keeping up with classes

In the graph below it is possible to see the results of the responses divided between the three clusters.

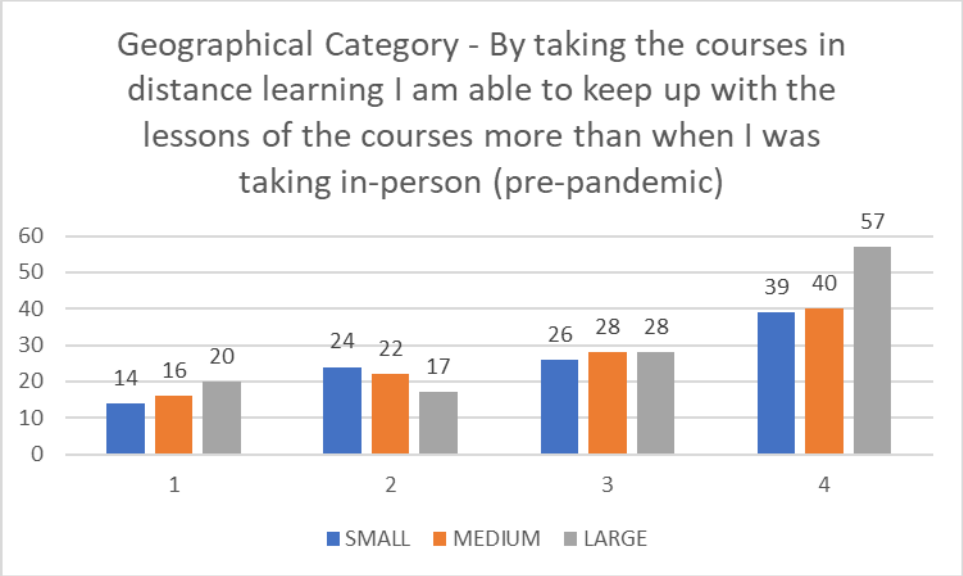


Table 70: Results for University size category - Ease in keeping up with classes

Using the excel tool, the following information about the ANOVA test conducted can be obtained:

Anova: Single Factor						
SUMMARY						
Groups	*Count*	*Sum*	*Average*	*Variance*		
SMALL	103	296	2,87	1,15		
MEDIUM	106	304	2,87	1,18		
LARGE	122	366	3	1,27		
ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	1,29	2	0,64	0,53	0,59	3,02
Within Groups	395,51	328	1,21			
Total	396,80	330				

Table 71: ANOVA Single factor - Ease in keeping up with classes for University size category

By performing the test, the p-value is found to be greater than alpha (0.05), therefore, the null hypothesis cannot be rejected.

Therefore, we can conclude that among the University Size Category, no substantial difference was found between the Likert scale responses to the statement " After taking classes in distance learning, I feel less ready for exams than when I took in-person (pre-pandemic)".

In general, it is possible to see that the average of the responses is around 3, so "Quite agree." for all clusters.

As could be seen in the analysis of the " By taking the courses in distance learning I am able to keep up with the lessons of the courses more than when I was taking in-person (pre-pandemic)" statement, in all three categories analyzed (University Path Category, Geographical Category, University Size Category) there were no significant differences between the clusters.

The mean response for all clusters always approximated 3 - Quite agree. Below the graph with all the answers:

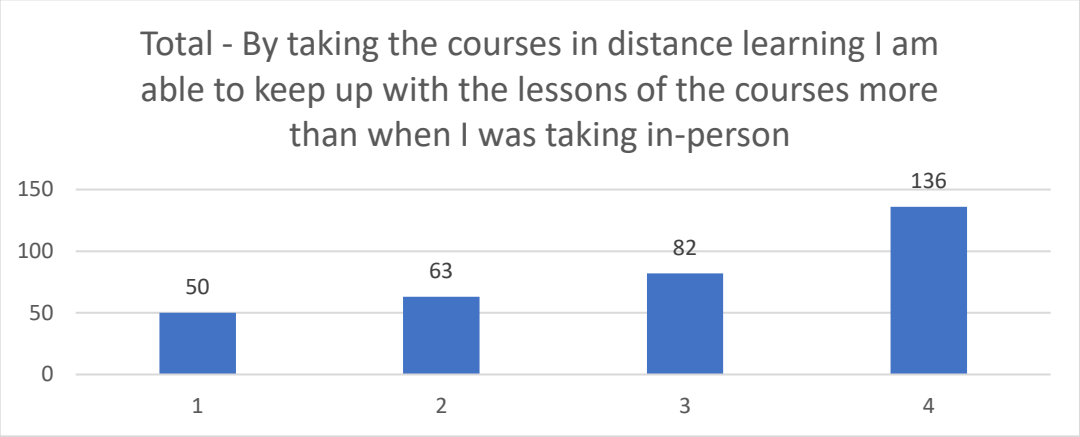


Table 72: Results for Total category - Ease in keeping up with classes

We can conclude by saying that distance learning can help Italian students in keeping up with the lessons more than the traditional learning.

Conducting the one sample t-test on all respondents to the survey, we set the following hypotheses (null and alternative):

Total Category	
H0	H1
There is NO significant difference between the values of the sample, compared with the value 3 – Quite agree	There is a significant difference between the values of the sample, compared with the value 3 – Quite agree

Table 73: H0 and H1 for Total category – Ease in keeping up with classes

Calculating through MS Excel the one sample t-test - two-tailed analysis, the outcome is the following:

ONE SAMPLE T TEST	
Mean	2,92
Standard deviation	1,10
Count	331,00
Standard error of mean	0,06
Degrees of freedom	330,00
Hypotized mean	3,00
t-statistic	1,35
p-value	0,18

Table 74: One sample t-test for Total category - Ease in keeping up with classes

The p-value is 0.18 and the alpha level is set at 0.05, so the p-value is grater the alpha level. I can not reject the null hypothesis.

5.2.3. Distance learning - great strengths

We have come to the point in the analysis where it is appropriate to understand what the major strengths of distance learning for Italian students are. For this reason, the following question was raised:

"What do you think is the greatest strength of distance learning?"

As mentioned in Chapter 3, this question was a semi-open question, i.e. a question for which it was also possible to fill in the "other" field with the answer people thought was most appropriate. For simplicity, the reworked answers are given below in the graph:

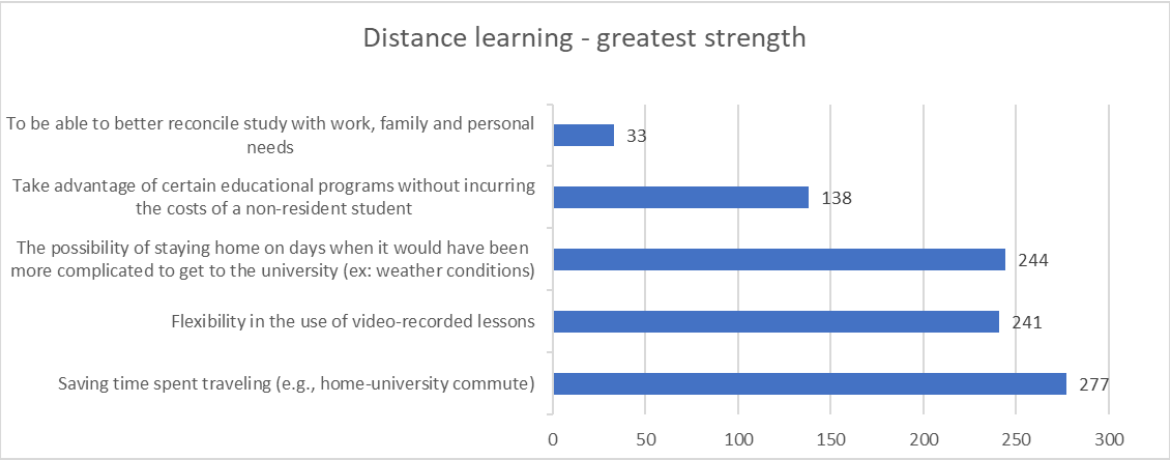


Table 75: Greatest strengths in distance learning for students

At this point it is interesting to try to see if there are any significant differences for each strength within the categories.

5.2.3.1. Saving time spent traveling (e,g, home-university commute)

Let's start with the top rated strength: "**Saving time spent traveling (e,g, home-university commute)**".

At this point we start by analyzing whether we can see significant differences within the ***University Path Category***.

We hypothesize, in fact, that there may be differences in the proportion of students attending science-oriented universities and students attending humanities-oriented universities that have included "Saving time spent traveling (e,g, home-university commute)" among the major strengths, because very often in humanities-oriented universities there are many courses with compulsory attendance. For these types of courses, it was necessary in the pre-pandemic context, to physically go to class in order to then take the exam. Therefore, it is hypothesized that humanities students voted more frequently on this strength.

The University Path category has the following characteristics:

- the question is a qualitative question;
- the category in question contains two clusters of students (students attending a science-based degree program and students attending a humanities-based degree program)

The appropriate statistical test for the purpose is the Chi-squares test for Homogeneity. Below the null hypothesis and the alternative hypothesis that were set for the test.

University Path Category	
H0	H1
The proportion of students who reported one of the greatest strengths of distance learning is “Saving time spent traveling” is the SAME among people who are attending a scientific or humanistic universities	The proportion of students who reported one of the greatest strengths of distance learning is “Saving time spent traveling” is DIFFERENT among people who are attending a scientific or humanistic universities

Table 76: H0 and H1 for University path category – Saving time spent traveling

In the graph below it is possible to see the results of the responses divided between the two clusters.

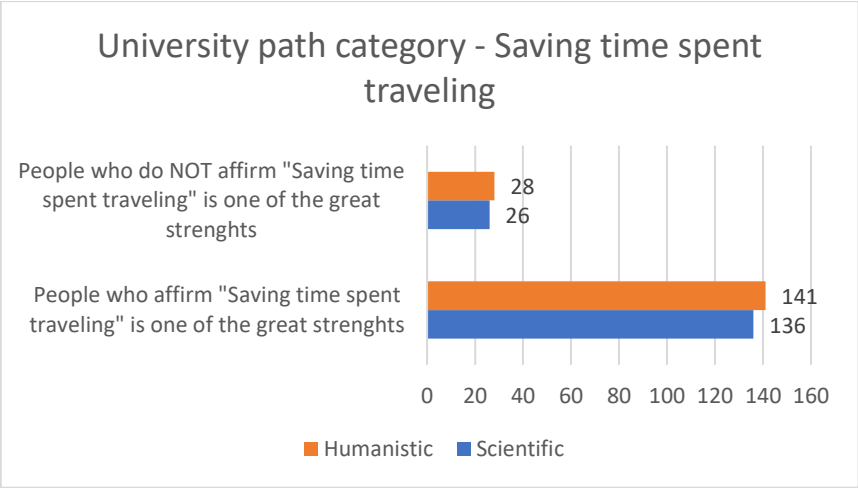


Table 77: Results for University path category - Saving time spent traveling

It can be seen from the graph that the percentage of students attending scientific universities who selected the "Saving time spent traveling" option is 15%, while the percentage for students in humanistic universities is 16%.

Using Excel the following calculations for the Chi-squares test have been conducted:

OBSERVED (O)			
	People who affirm "Saving time spent traveling" is one of the great strenghts	People who do NOT affirm "Saving time spent traveling" is one of the great strenghts	
Scientific	136	26	162
Humanistic	141	28	169
	277	54	331

EXPECTED (E)		
	People who affirm "Saving time spent traveling" is one of the great strenghts	People who do NOT affirm "Saving time spent traveling" is one of the great strenghts
Scientific	135,57	26,43
Humanistic	141,43	27,57

$(O-E)^2/E$		
	People who affirm "Saving time spent traveling" is one of the great strenghts	People who do NOT affirm "Saving time spent traveling" is one of the great strenghts
Scientific	0,001	0,007
Humanistic	0,001	0,007

X^2	0,02
df	1
p-value	0,90

Table 78: Chi-squares test for homogeneity - Saving time spent traveling for University path category

By performing the test, the p-value is found to be greater than alpha (0.05), therefore, the null hypothesis cannot be rejected.

For extreme confirmation the test of the comparison of two population proportion can also be carried out. Using excel, the calculations obtained are as follows:

	H0	**p1-p2 = 0**	
	H1	**p1-p2 ≠ 0**	
1 = Scientific	p1	0,84	
2 = Humanistic	p2	0,83	
	Var1	0,001	
	Var2	0,001	
	alpha	0,05	
	Z	0,13	
	p-value	0,9	>0,05

Table 79: Comparison of two population proportion - Saving time spent traveling - University path category

Again, the p-value is greater than 0.05, so it confirms the result of the test done previously. The alternative hypothesis is rejected, accepting the null hypothesis.

Therefore, we can conclude that among scientific path students and humanistic path students, no substantial difference was found and the conclusion is that the differences are consistent with being explained by sampling error.

We can therefore say that the initial hypothesis that saw compulsory attendance as a discriminating factor is not true.

At this point it is possible to continue the analysis with the ***Geographical category***.

Indeed, we hypothesize that there may be differences among students in different geographical areas of Italy, as it is well known that there are areas in Italy where transportation works better than others. The writer expects that students in northern Italy voted less frequently for the alternative "Saving time spent traveling (e,g, home-university commute)" because greater ease in getting around translates into less time spent traveling to get to the university.

Given that:

- the question is a qualitative question;
- the category in question contains two clusters of students (Students from universities located in the North of Italy - Students from universities located in the Center of Italy - Students from universities located in the South of Italy)

The appropriate statistical test for the purpose is the Chi-squares test for Homogeneity. Below the null hypothesis and the alternative hypothesis that were set for the test.

Geographical Category	
H0	H1
The proportion of students who reported one of the greatest strengths of distance learning is “Saving time spent traveling” is the SAME among people who are studying in a university located in the North – Center – South of Italy	The proportion of students who reported one of the greatest strengths of distance learning is “Saving time spent traveling” is DIFFERENT among people who are studying in a university located in the North – Center – South of Italy

Table 80: H0 and H1 for Geographical category – Saving time spent traveling

In the graph below it is possible to see the results of the responses divided between the three clusters.

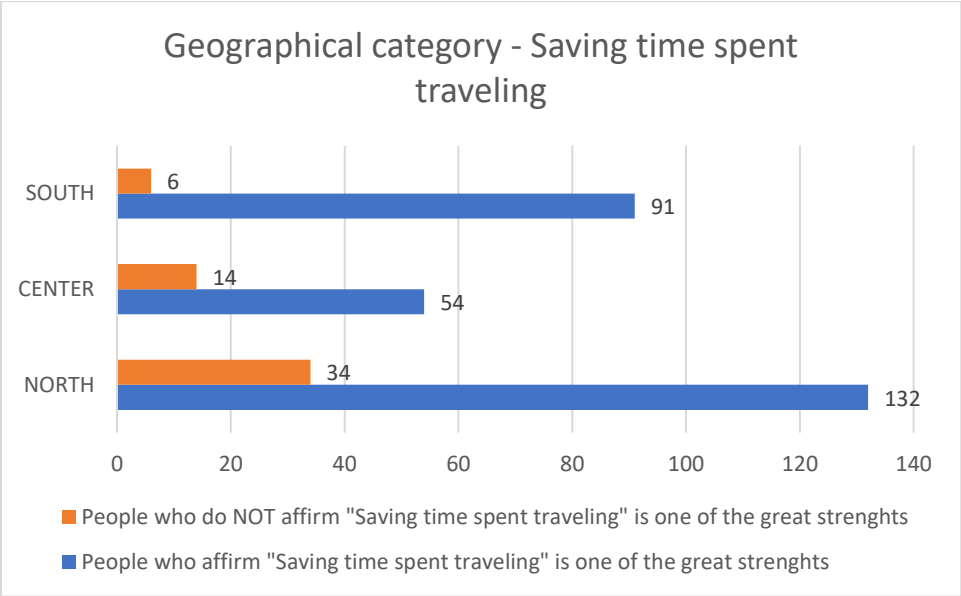


Table 81: Results for Geographical category - Saving time spent traveling

Using Excel the following calculations for the Chi-squares test have been conducted:

OBSERVED (O)			
	People who affirm "Saving time spent traveling" is one of the great strenghts	People who do NOT affirm "Saving time spent traveling" is one of the great strenghts	
NORTH	132	34	166
CENTER	54	14	68
SOUTH	91	6	97
	277	54	331

EXPECTED (E)		
	People who affirm "Saving time spent traveling" is one of the great strenghts	People who do NOT affirm "Saving time spent traveling" is one of the great strenghts
NORTH	138,92	27,08
CENTER	56,91	11,09
SOUTH	81,18	15,82

$(O-E)^2/E$		
	People who affirm "Saving time spent traveling" is one of the great strenghts	People who do NOT affirm "Saving time spent traveling" is one of the great strenghts
NORTH	0,34	1,77
CENTER	0,15	0,76
SOUTH	1,19	6,10

X^2	10,31
df	2
p-value	0,006

Table 82: Chi-squares test for homogeneity - Saving time spent traveling for Geographical category

As can easily be seen, the p-value in this case is less than the alpha level 0.05. So, there is a significant difference between the clusters in the geographical category.

We must now go on to identify which of the categories differs from the others. To do this, 3 more chi-spares tests like the one just performed are conducted, comparing the three categories in pairs. However, even before taking the test one can easily see from the graph above that 94% of people attending universities in southern Italy entered "Saving time spent traveling (e.g., home-university commute)" as one of the major advantages. In contrast, students attending universities in northern and central Italy have percentages both of 79%.

Comparing northern students with central students by Chi-squares test, it can be easily seen that there are no significant differences, as the p-value is greater than 0.05.

NORTH VS CENTER

OBSERVED (O)

	People who affirm "Saving time spent traveling" is one of the great strenghts	People who do NOT affirm "Saving time spent traveling" is one of the great strenghts	
NORTH	132	34	166
CENTER	54	14	68
	186	48	234

EXPECTED (E)

	People who affirm "Saving time spent traveling" is one of the great strenghts	People who do NOT affirm "Saving time spent traveling" is one of the great strenghts
NORTH	131,95	34,05
CENTER	54,05	13,95

$(O-E)^2/E$

	People who affirm "Saving time spent traveling" is one of the great strenghts	People who do NOT affirm "Saving time spent traveling" is one of the great strenghts
NORTH	2E-05	8E-05
CENTER	5E-05	2E-04

X^2	0,0003
df	1
p-value	0,99

Table 83: Post-hoc test Chi squares for homogeneity - Saving time spent traveling for North VS Center clusters

Looking instead at the tests done with the North VS South and Center VS South pairs, the p-value is lower in both cases. This means that the proportion of students from Southern Italy who answered that one of the biggest advantages of distance education is "Saving time spent traveling (e.g., home-university commute)" is higher than that of students from the North and Center

NORTH VS SOUTH

OBSERVED (O)

	People who affirm "Saving time spent traveling" is one of the great strenghts	People who do NOT affirm "Saving time spent traveling" is one of the great strenghts	
NORTH	132	34	166
SOUTH	91	6	97
	223	40	263

EXPECTED (E)

	People who affirm "Saving time spent traveling" is one of the great strenghts	People who do NOT affirm "Saving time spent traveling" is one of the great strenghts
NORTH	140,7528517	25,24714829
SOUTH	82,24714829	14,75285171

$(O-E)^2/E$

	People who affirm "Saving time spent traveling" is one of the great strenghts	People who do NOT affirm "Saving time spent traveling" is one of the great strenghts
NORTH	0,544304518	3,034497687
SOUTH	0,931490206	5,193057897

X^2	9,703350307
df	1
p-value	0,00184

Table 84: Post-hoc test Chi squares for homogeneity - Saving time spent traveling for North VS South clusters

CENTER VS SOUTH

OBSERVED (O)

	People who affirm "Saving time spent traveling" is one of the great strenghts	People who do NOT affirm "Saving time spent traveling" is one of the great strenghts	
CENTER	54	14	68
SOUTH	91	6	97
	145	20	165

EXPECTED (E)

	People who affirm "Saving time spent traveling" is one of the great strenghts	People who do NOT affirm "Saving time spent traveling" is one of the great strenghts
CENTER	59,75757576	8,242424242
SOUTH	85,24242424	11,75757576

$(O-E)^2/E$

	People who affirm "Saving time spent traveling" is one of the great strenghts	People who do NOT affirm "Saving time spent traveling" is one of the great strenghts
CENTER	0,554736001	4,021836007
SOUTH	0,388887093	2,819431428

X^2	7,784890529
df	1
p-value	0,00527

Table 85: Post-hoc test Chi squares for homogeneity - Saving time spent traveling for South VS Center clusters

It is therefore possible that the initial hypothesis that southern Italian students are more likely to see as one of the major advantages of distance education "Saving time spent traveling" may be true.

5.2.3.2. Take advantage of certain educational programs without incurring the costs of a non-resident student

Now analyzing the strength "Take advantage of certain educational programs without incurring the costs of a non-resident student", which received a total of 138 votes, we can reflect on the following hypothesis using ***Geographical category*** as the category to be analyzed:

It is well known that during the university period many students choose universities far from home, thus becoming non-resident students. This is certainly an important step, both for students and their families, as they incur significant costs: rent, transportation, and life away from home in general create monthly outlays that are, despite financial assistance grants, quite difficult for many families to bear.

In Italy, there are many students residing in southern Italy who choose to go to study at universities in central or northern Italy.

In fact, according to the Talents Venture Observatory[24], 32% of college students from southern Italy attend university far from home. In addition, Lombardy and Emilia Romagna alone gather 36% of students who decide to study outside the region. It is therefore interesting to go and see through appropriate statistical tests whether among students studying at universities in North of Italy there is a higher frequency than in the other two geographical areas of people who voted "Take advantage of certain educational programs without incurring the costs of a non-resident student" as one of the major strengths of distance education.

Given that:

- the question is a qualitative question;
- the category in question contains two clusters of students (Students from universities located in the North of Italy - Students from universities located in the Center of Italy - Students from universities located in the South of Italy)

The appropriate statistical test for the purpose is the Chi-squares test for Homogeneity. Below the null hypothesis and the alternative hypothesis that were set for the test.

[24] https://www.talentsventure.com/wp-content/uploads/2019/07/Il-fenomeno-degli-studenti-fuori-sede.-I-talenti-emigrano-dal-Meridione-e-riempiono-i-grandi-atenei..pdf

Geographical Category	
H0	H1
The proportion of students who reported one of the greatest strengths of distance learning is “Take advantage of certain educational programs without incurring the costs of a non-resident student” is the SAME among people who are studying in a university located in the North – Center – South of Italy	The proportion of students who reported one of the greatest strengths of distance learning is “Take advantage of certain educational programs without incurring the costs of a non-resident student ” is DIFFERENT among people who are studying in a university located in the North – Center – South of Italy

Table 86: H0 and H1 for Geographical category – Take advantage of certain educational programs

In the graph below it is possible to see the results of the responses divided between the three clusters.

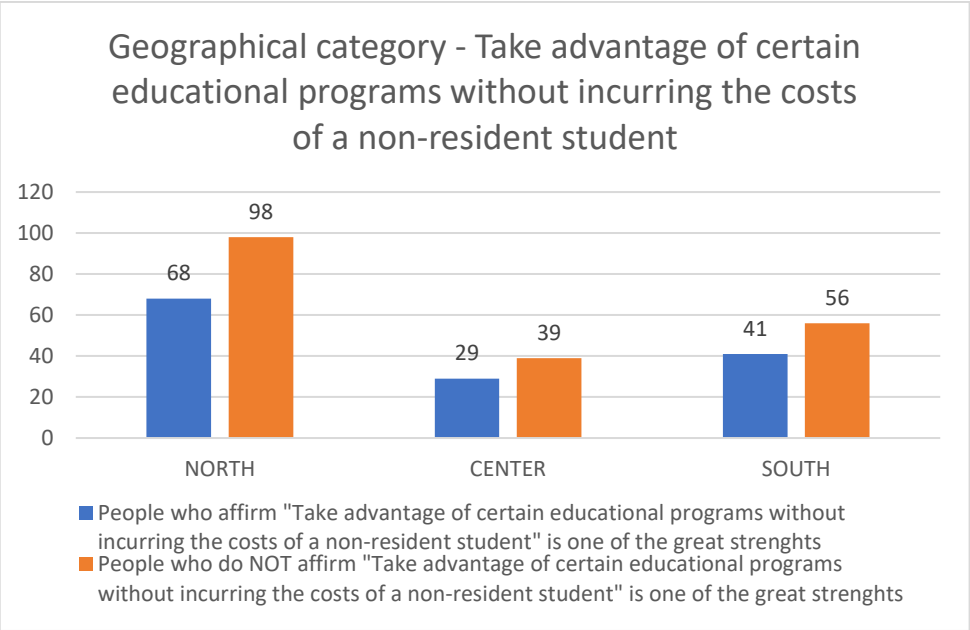


Table 87: Results for Geographical category - Take advantage of certain educational programs

From this graph we can begin to see that, the percentages of students in the three clusters selected as one of the major strengths of distance education "Take advantage of certain educational programs without incurring the costs of a non-resident student " are very similar to each other. In fact, for the North, Central and South clusters the percentages are 41%, 43% and 42%, respectively. Thus we see that among the clusters there is not a big difference in the proportion. Carrying out the statistical test gives the following result:

OBSERVED (O)			
	People who affirm "Take advantage of certain educational programs without incurring the costs of a non-resident student" is one of the great strenghts	People who do NOT affirm "Take advantage of certain educational programs without incurring the costs of a non-resident student" is one of the great strenghts	
NORTH	68	98	166
CENTER	29	39	68
SOUTH	41	56	97
	138	193	331

EXPECTED (E)		
	People who affirm "Take advantage of certain educational programs without incurring the costs of a non-resident student" is one of the great strenghts	People who do NOT affirm "Take advantage of certain educational programs without incurring the costs of a non-resident student" is one of the great strenghts
NORTH	69,21	96,79
CENTER	28,35	39,65
SOUTH	40,44	56,56

$(O-E)^2/E$		
	People who affirm "Take advantage of certain educational programs without incurring the costs of a non-resident student" is one of the great strenghts	People who do NOT affirm "Take advantage of certain educational programs without incurring the costs of a non-resident student" is one of the great strenghts
NORTH	0,02	0,02
CENTER	0,01	0,01
SOUTH	0,01	0,01

X^2	0,07
df	2
p-value	0,96

Table 88: Chi-squares test for homogeneity - Take advantage of certain educational programs for Geographical category

As can be seen, the p-value is 0.96 and is therefore greater than 0.05. Therefore, we can conclude that among the geographical category, no substantial difference was found and the conclusion is that the differences are consistent with being explained by sampling error.

This may be given by the fact that even if in Southern Italy it turns out that more students move to another region to go study, it is also true that there are many students, and they are probably evenly distributed throughout Italy, who even if they do not change regions to go study, still move to the city where the university is located because it would not be possible to commute every day.

It is therefore possible that this is why we do not find a significant difference in the frequency of the three clusters, and we reject the initial hypothesis that saw the students studying at universities in North of Italy as more inclined to vote "Take advantage of certain educational programs without incurring the costs of a non-resident student" as one of the major strengths of distance learning.

5.2.3.3. The possibility of staying home on days when it would have been more complicated to get to the university (ex: weather conditions)

At this point I would continue the analysis of the strengths most found by Italian students by analyzing the second highest rated "The possibility of staying home on days when it would have been more complicated to get to the university (ex: weather conditions)".

We hypothesize that people attending universities located in northern Italy are more likely to see this as a major strength, so they voted for it to a greater extent than the other clusters in the ***Geographical category***. This is because northern Italy has colder temperatures in winter than may be found in southern or central Italy.

Given that:

- the question is a qualitative question;

- the category in question contains two clusters of students (Students from universities located in the North of Italy - Students from universities located in the Center of Italy - Students from universities located in the South of Italy)

The appropriate statistical test for the purpose is the Chi-squares test for Homogeneity. Below the null hypothesis and the alternative hypothesis that were set for the test.

Geographical Category	
H0	H1
The proportion of students who reported one of the greatest strengths of distance learning is "The possibility of staying home on days when it would have been more complicated to get to the university (ex: weather conditions)" is the SAME among people who are studying in a university located in the North – Center – South of Italy	The proportion of students who reported one of the greatest strengths of distance learning is " The possibility of staying home on days when it would have been more complicated to get to the university (ex: weather conditions)" is DIFFERENT among people who are studying in a university located in the North – Center – South of Italy

Table 89: H0 and H1 for University path category – The possibility of staying home in particular days

In the graph below it is possible to see the results of the responses divided between the three clusters.

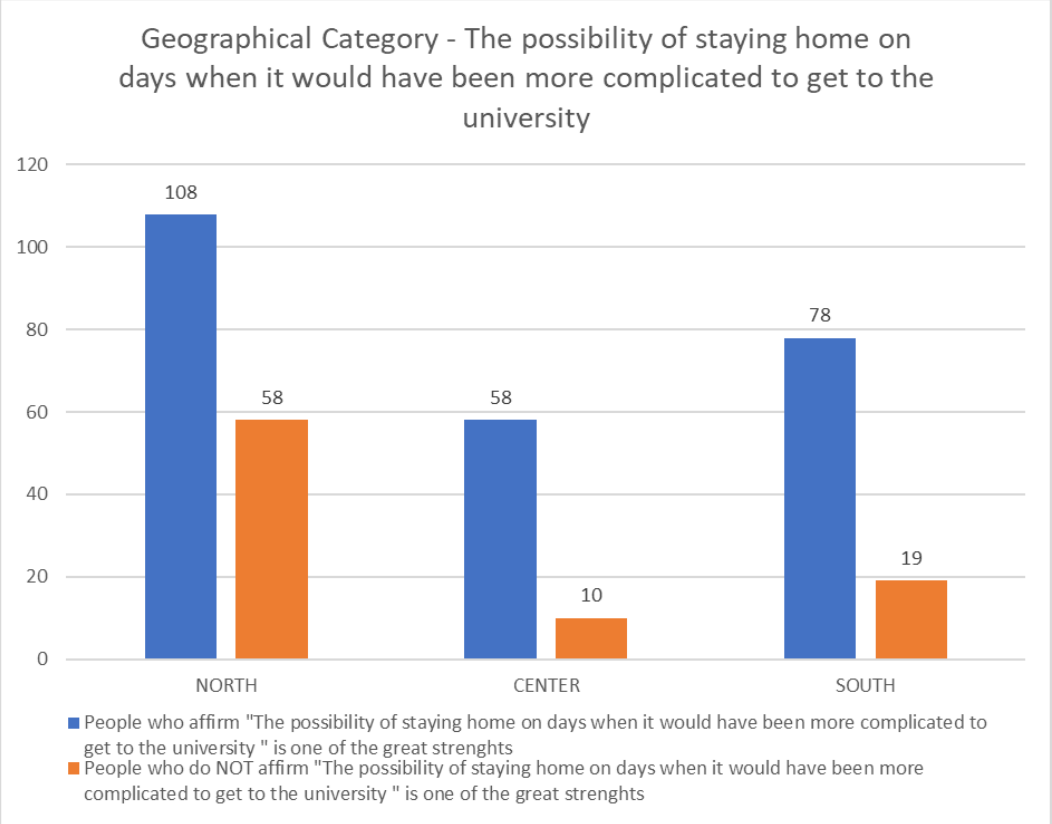


Table 90: Results for Geographical category - The possibility of staying home in particular days

Looking at the graph, the percentage of people who voted "The possibility of staying home on days when it would have been more complicated to get to the university " as one of the major strenghts among Northern, Central and Southern Italy is respectively: 65%, 85% and 80%.

Conducting the statistical test gives the following result:

OBSERVED (O)

	People who affirm "The possibility of staying home on days when it would have been more complicated to get to the university " is one of the great strenghts	People who do NOT affirm "The possibility of staying home on days when it would have been more complicated to get to the university " is one of the great strenghts	
NORTH	108	58	166
CENTER	58	10	68
SOUTH	78	19	97
	244	87	331

EXPECTED (E)

	People who affirm "The possibility of staying home on days when it would have been more complicated to get to the university " is one of the great strenghts	People who do NOT affirm "The possibility of staying home on days when it would have been more complicated to get to the university " is one of the great strenghts
NORTH	122,37	43,63
CENTER	50,13	17,87
SOUTH	71,50	25,50

$(O-E)^2/E$

	People who affirm "The possibility of staying home on days when it would have been more complicated to get to the university " is one of the great strenghts	People who do NOT affirm "The possibility of staying home on days when it would have been more complicated to get to the university " is one of the great strenghts
NORTH	1,69	4,73
CENTER	1,24	3,47
SOUTH	0,59	1,65

X^2	13,37
df	2
p-value	0,001

Table 91: Chi-squares test for homogeneity - The possibility of staying home in particular days for Geographical category

As can easily be seen, the p-value is 0.001, so it is lower than the alpha level 0.05. There is a significant difference between the clusters in the geographical category.

Comparing southern students with central students by Chi-squares test, it can be easily seen that there are no significant differences, as the p-value is greater than 0.05.

CENTER VS SOUTH

OBSERVED (O)

	People who affirm "The possibility of staying home on days when it would have been more complicated to get to the university " is one of the great strenghts	People who do NOT affirm "The possibility of staying home on days when it would have been more complicated to get to the university " is one of the great strenghts	
CENTER	58	10	68
SOUTH	78	19	97
	136	29	165

EXPECTED (E)

	People who affirm "The possibility of staying home on days when it would have been more complicated to get to the university " is one of the great strenghts	People who do NOT affirm "The possibility of staying home on days when it would have been more complicated to get to the university " is one of the great strenghts
CENTER	56,05	11,95
SOUTH	79,95	17,05

$(O-E)^2/E$

	People who affirm "The possibility of staying home on days when it would have been more complicated to get to the university " is one of the great strenghts	People who do NOT affirm "The possibility of staying home on days when it would have been more complicated to get to the university " is one of the great strenghts
CENTER	0,07	0,32
SOUTH	0,05	0,22

X^2	0,66
df	1
p-value	0,42

Table 92: Post-hoc test Chi squares for homogeneity - Saving time spent traveling for South VS Center clusters

Looking instead at the tests done with the North VS South and Center VS North pairs, the p-value is lower in both cases. This means that the proportion of students from Northern Italy who answered that one of the biggest advantages of distance education is "The possibility of staying home on days when it would have been more complicated to get to the university (ex: weather conditions)" is lower than that of students from the South and Center of Italy.

NORTH VS CENTER

OBSERVED (O)

	People who affirm "The possibility of staying home on days when it would have been more complicated to get to the university " is one of the great strenghts	People who do NOT affirm "The possibility of staying home on days when it would have been more complicated to get to the university " is one of the great strenghts	
NORTH	108	58	166
CENTER	58	10	68
	166	68	234

EXPECTED (E)

	People who affirm "The possibility of staying home on days when it would have been more complicated to get to the university " is one of the great strenghts	People who do NOT affirm "The possibility of staying home on days when it would have been more complicated to get to the university " is one of the great strenghts
NORTH	117,76	48,24
CENTER	48,24	19,76

$(O-E)^2/E$

	People who affirm "The possibility of staying home on days when it would have been more complicated to get to the university " is one of the great strenghts	People who do NOT affirm "The possibility of staying home on days when it would have been more complicated to get to the university " is one of the great strenghts
NORTH	0,81	1,97
CENTER	1,97	4,82

X^2	9,58
df	1
p-value	0,002

Table 93: Post-hoc test Chi squares for homogeneity - Saving time spent traveling for North VS Center clusters

NORTH VS SOUTH

OBSERVED (O)

	People who affirm "The possibility of staying home on days when it would have been more complicated to get to the university " is one of the great strenghts	People who do NOT affirm "The possibility of staying home on days when it would have been more complicated to get to the university " is one of the great strenghts	
NORTH	108	58	166
SOUTH	78	19	97
	186	77	263

EXPECTED (E)

	People who affirm "The possibility of staying home on days when it would have been more complicated to get to the university " is one of the great strenghts	People who do NOT affirm "The possibility of staying home on days when it would have been more complicated to get to the university " is one of the great strenghts
NORTH	117,40	48,60
SOUTH	68,60	28,40

$(O-E)^2/E$

	People who affirm "The possibility of staying home on days when it would have been more complicated to get to the university " is one of the great strenghts	People who do NOT affirm "The possibility of staying home on days when it would have been more complicated to get to the university " is one of the great strenghts
NORTH	0,75	1,82
SOUTH	1,29	3,11

X^2	6,97
df	1
p-value	0,01

Table 94: Post-hoc test Chi squares for homogeneity - Saving time spent traveling for South VS North clusters

Thus, the trend that can be seen from the test just conducted is opposite to what the writer initially assumed. Students belonging to universities located in northern Italy voted less frequently the option analyzed than students from universities located in central and southern Italy.

Most likely this is given by the fact that, despite the very cold temperatures in northern Italy, public transportation functioning better than in other parts of Italy, this compensates for the difficulties that a harsh climate can bring.

5.2.3.4. Flexibility in the use of video-recorded lessons

Continuing the analysis of the greatest strengths found by Italian students, I would analyze the strength "Flexibility in the use of video-recorded lessons" for the ***University Path Category***.

We hypothesize, in fact, that the clusters that contains people who attends universities with scientific paths voted more frequently this strength, as their courses are often very full of mathematical exercises and demonstrations that can often be useful to review several times or to see at a slower speed than the professor goes at when explaining. This is because they are often concepts that are difficult to fully assimilate on first listen, so having the ability to be able to listen again to the professor's explanation on demand can be very useful.

The University Path Category has the following characteristics:

- the question is a qualitative question;
- the category in question contains two clusters of students (students attending a science-based degree program and students attending a humanities-based degree program)

The appropriate statistical test for the purpose is the Chi-squares test for Homogeneity. Below the null hypothesis and the alternative hypothesis that were set for the test.

University Path Category	
H0	H1
The proportion of students who reported one of the greatest strengths of distance learning is “Flexibility in the use of video-recorded lessons” is the SAME among people who are attending a scientific or humanistic universities	The proportion of students who reported one of the greatest strengths of distance learning is “ Flexibility in the use of video-recorded lessons ” is DIFFERENT among people who are attending a scientific or humanistic universities

Table 95: H0 and H1 for University path category – Flexibility in the use of video-recorded lessons

In the graph below it is possible to see the results of the responses divided between the two clusters.

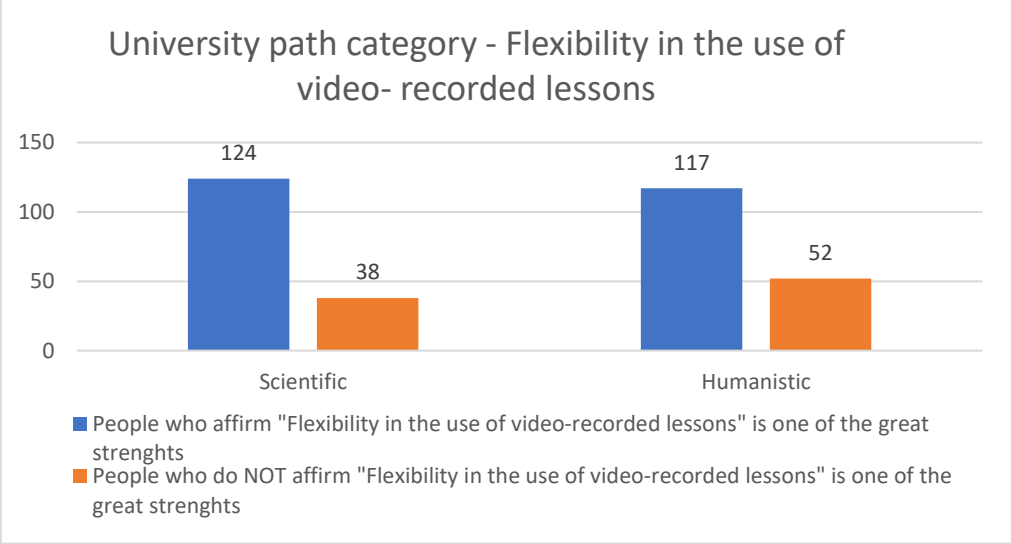


Table 96: Results for University path category - Flexibility in the use of video-recorded lessons

Using Excel the following calculations for the Chi-squeres test have been conducted:

OBSERVED (O)			
	People who affirm "Flexibility in the use of video-recorded lessons" is one of the great strenghts	People who do NOT affirm "Flexibility in the use of video-recorded lessons" is one of the great strenghts	
Scientific	124	38	162
Humanistic	117	52	169
	241	90	331

EXPECTED (E)		
	People who affirm "Flexibility in the use of video-recorded lessons" is one of the great strenghts	People who do NOT affirm "Flexibility in the use of video-recorded lessons" is one of the great strenghts
Scientific	117,95	44,05
Humanistic	123,05	45,95

$(O-E)^2/E$		
	People who affirm "Flexibility in the use of video-recorded lessons" is one of the great strenghts	People who do NOT affirm "Flexibility in the use of video-recorded lessons" is one of the great strenghts
Scientific	0,31	0,83
Humanistic	0,30	0,80

X^2	2,23
df	1
p-value	0,13

By performing the test, the p-value is found to be greater than alpha (0.05), therefore, the null hypothesis can not be rejected.

For extreme confirmation the test of the comparison of two population proportion can also be carried out. Using excel, the calculations obtained are as follows:

	H0	**p1-p2 = 0**
	H1	**p1-p2 ≠ 0**
1 = Scientific	p1	0,77
2 = Humanistic	p2	0,69
	Var1	0,001
	Var2	0,001
	alpha	0,05
	Z	1,50
	p-value	0,134

Table 97: Comparison of two population proportion - University path category – Flexibility in the use of video-recorded lessons

Again, the p-value is greater than 0.05, so it confirms the result of the test done previously. The alternative hypothesis is rejected, accepting the null hypothesis.

Therefore, we can conclude that among scientific path students and humanistic path students, no substantial difference was found and the conclusion is that the differences are consistent with being explained by sampling error.

Thus, the initial hypothesis that students at science-oriented universities were more likely to select as one of the greatest strengths of distance education “Flexibility in the use of video-recorded lessons" has been refuted. It is probably true that science universities have more abstruse concepts, so the video lecture turns out to be a great help for the student, but even for students attending humanities universities, video lectures are extremely convenient because they allow them to organize in their own time.

5.2.1. External environment, is it important?

At this point in the analysis of the major differences for students between traditional and distance learning, it is interesting to make the consideration that the reader can find in the next few lines.

When following in-presence, the student simply enters the physical classroom where the lecture takes place, the professor explains, the exercises are done, and afterwards they return home. Everything is done in an environment prepared for study and learning. So, for all the students following that particular lesson, the experience is essentially identical: they all hear the same voice, see the same blackboard and the same things. There is no difference if you make the assumption that the classrooms are always correctly sized for the number of students who have to take the lessons.

If, on the other hand, we consider the case of online education, surely the learning experience during the lesson is not the same for everyone.

If, on the other hand, we consider the case of online education, surely the learning experience during the lesson is not the same for everyone. There are so many external variables that come into play, which we can encapsulate in the three points in the following bulleted list:

If, on the other hand, we consider the case of online education, surely the learning experience during the lesson is not the same for everyone. There are so many external variables that come into play, which we can encapsulate in the three points in the following bulleted list:

- Quality of the device being used to follow the lectures
- Quality of the Internet connection you have
- Quality of the study station

These three points, in order to have a smooth learning experience, must all have ahigh or medium-high quality. It is not at all a given that all students have the opportunity to enjoy good quality of all three.

In fact, the house in which one lives is not a place designed solely and exclusively for studying. It is very common for students to live in crowded houses (with family, or with roommates), and this often generates difficulties in connecting to the Internet, or a lack of quiet spaces in which to sit to take online classes.

For this reason, the three questions about the external environment were asked, namely the question about the quality of the PC, Internet connection, and study station that is available.

If we go to filter out the people who answered YES to all three questions, it can be seen that only 37% of students can say that they are fully satisfied with both the PC, the connection, and the study station. For the sake of simplicity, the above people will henceforth be referred to as "students with an optimal external environment", while

people who did not answer YES to at least one of the three questions will be "students with a NOT optimal external environment".

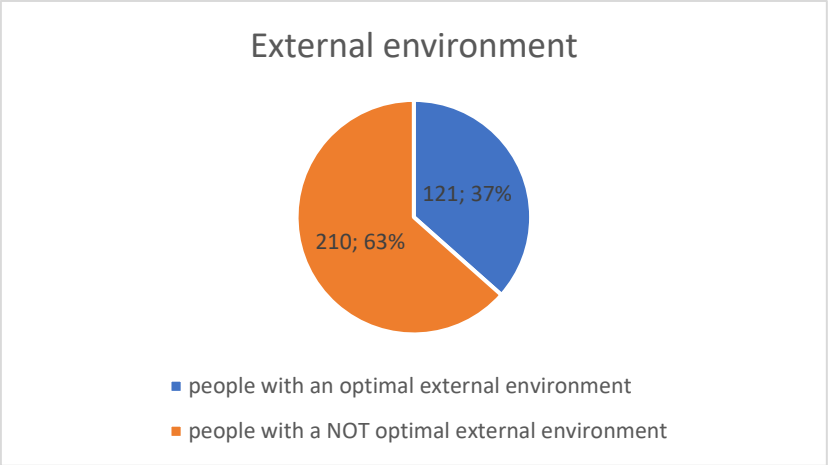


Table 98: Distribution of respondents inside the External environment category

For simplicity, it is useful to enclose the above two clusters within a category that we will call "**External environment category**".

5.2.2. Distance learning – big weaknesses

In the same way that we have analyzed the major strengths found by students, it is now important to go over what are the major disadvantages that students find in distance learning. For this reason, the following question was raised:

"What do you think is the greatest strength of distance learning?"

As for the question about great strengths of distance learning, this question was a semi-open question, i.e., a question for which it was also possible to fill in the "other" field with the answer people thought was most appropriate. For simplicity, the reworked answers are given below in the graph.

At this point it is interesting to try to see if there are any significant differences for each weakness within the categories.

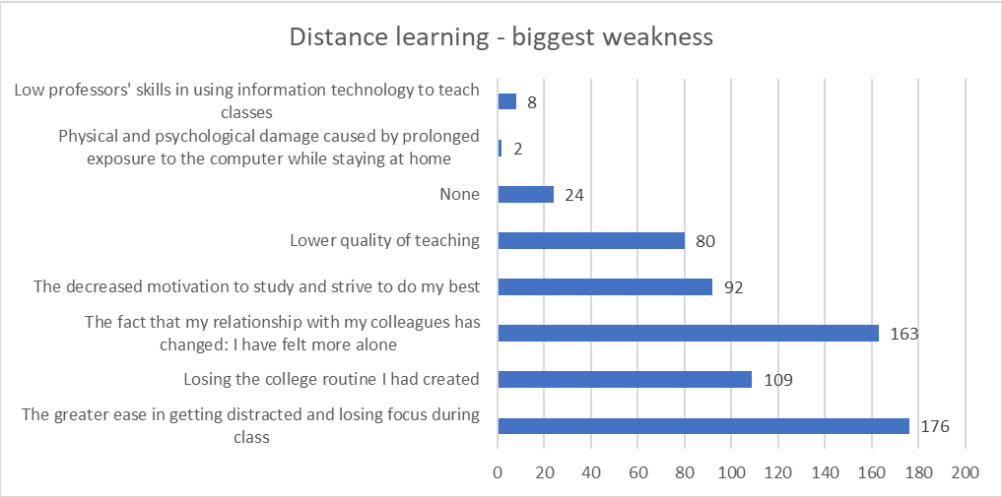


Table 99: Distance learning - biggest weakness

At this point it is interesting to try to see if there are any significant differences for each weakness within the categories.

5.2.2.1. The greater ease in getting distracted and losing focus during class

Let's start with the top rated weakness: "**The greater ease in getting distracted and losing focus during class**".

At this point we start by analyzing whether we can see significant differences within the ***External environment category***.

Indeed, we hypothesize that people who do not have an optimal external environment are more likely to be distracted when taking online classes. This could precisely be because there are other people at home going about their jobs, their lives, or the inadequate computer support.

The External environment category has the following characteristics:

- the question is a qualitative question;
- the category in question contains two clusters of students (students with an optimal external environment and students with a NOT optimal external environment).

The appropriate statistical test for the purpose is the Chi-squares test for Homogeneity. Below the null hypothesis and the alternative hypothesis that were set for the test.

External environment Category	
H0	H1
The proportion of students who reported one of the big weaknesses of distance learning is "The greater ease in getting distracted and losing focus during class" is the SAME among people	The proportion of students who reported one of the big weaknesses of distance learning is "The greater ease in getting distracted and losing focus during class" is DIFFERENT among people who have an optimal

who have an optimal external environment and who have not.	external environment and who have not.

Table 100: H0 and H1 for External environment category – Focus loss

In the graph below it is possible to see the results of the responses divided between the two clusters.

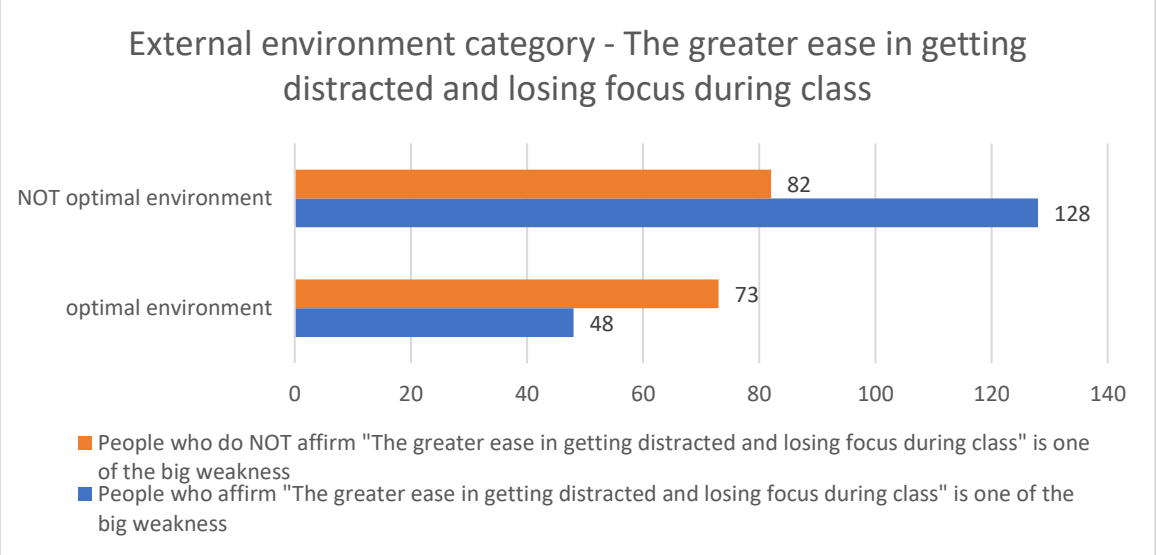


Table 101: Results for External environment category - Focus loss

As can be easily seen, the frequency of people who voted "The greater ease in getting distracted and losing focus during class" as one of the biggest weaknesses of online education is very different between the two clusters in the External environment category: NOT optimal cluster: 61%, optimal cluster: 40%.

Using Excel, the following calculations for the Chi-squares test have been conducted:

OBSERVED (O)

	People who affirm "The greater ease in getting distracted and losing focus during class" is one of the big weakness	People who do NOT affirm "The greater ease in getting distracted and losing focus during class" is one of the big weakness	
optimal environment	48	73	121
NOT optimal environment	128	82	210
	176	155	331

EXPECTED (E)

	People who affirm "The greater ease in getting distracted and losing focus during class" is one of the big weakness	People who do NOT affirm "The greater ease in getting distracted and losing focus during class" is one of the big weakness
optimal environment	64,34	56,66
NOT optimal environment	111,66	98,34

$(O-E)^2/E$

	People who affirm "The greater ease in getting distracted and losing focus during class" is one of the big weakness	People who do NOT affirm "The greater ease in getting distracted and losing focus during class" is one of the big weakness
optimal environment	4,15	4,71
NOT optimal environment	2,39	2,71

X^2	13,97
df	1
p-value	0,00

Table 102: Chi-squares test for homogeneity - Focus loss for External environment category

As can easily be seen, the p-value is 0.0002, so it is lower than the alpha level 0.05. There is a significant difference between the clusters in the external environment category.

For extreme confirmation the test of the comparison of two population proportion can also be carried out. Using excel, the calculations obtained are as follows:

	H0	**p1-p2 = 0**	
	H1	**p1-p2 ≠ 0**	
1 = Optimal environment	p1	0,40	
2 = NOT optimal environment	p2	0,61	
	Var1	0,00	
	Var2	0,00	
	alpha	0,05	
	Z	-3,82	NOT included between (-1,96;1,96)
	p-value	0,0001	

Table 103: Comparison of two population proportion for External environment category - Focus loss

Again, the p-value is less than 0.05, so it confirms the result of the test done previously. The null hypothesis is rejected, accepting the alternative hypothesis.

Rejecting the null hypothesis in favor of the alternative hypothesis, we can therefore say that the frequency with which students who do not enjoy optimal external conditions selected as one of the major disadvantages of the dad " The greater ease in getting distracted and losing focus during class" is greater than the cluster of students who reported having optimal external conditions.

5.2.2.2. The decreased motivation to study and strive to do my best

Another disadvantage that was highly rated in the survey was "**The decreased motivation to study and strive to do my best**", which is very worrisome considering that curiosity and the desire to learn for oneself first is fundamental in the college path. So, it is interesting to see if there are substantial differences between students in humanities and science universities.

We hypothesize that science universities, given their inherent complexity have registered a higher frequency of voters at this disadvantage. When a course of study is particularly tortuous, it is indeed easy to feel a somewhat lost and consequently lose motivation.

The ***University Path category*** has the following characteristics:

- the question is a qualitative question;
- the category in question contains two clusters of students (students attending a science-based degree program and students attending a humanities-based degree program).

The appropriate statistical test for the purpose is the Chi-squares test for Homogeneity. Below the null hypothesis and the alternative hypothesis that were set for the test.

Homogeneity. Below the null hypothesis and the alternative hypothesis that were set for the test.

University Path Category	
H0	H1
The proportion of students who reported one of the big disadvantages of distance learning is "The decreased motivation to study and strive to do my best" is the SAME among people who are attending a scientific or humanistic universities	The proportion of students who reported one of the big disadvantages of distance learning is "The decreased motivation to study and strive to do my best" is DIFFERENT among people who are attending a scientific or humanistic universities

Table 104: H0 and H1 for University path category - Motivation to study

In the graph below it is possible to see the results of the responses divided between the two clusters.

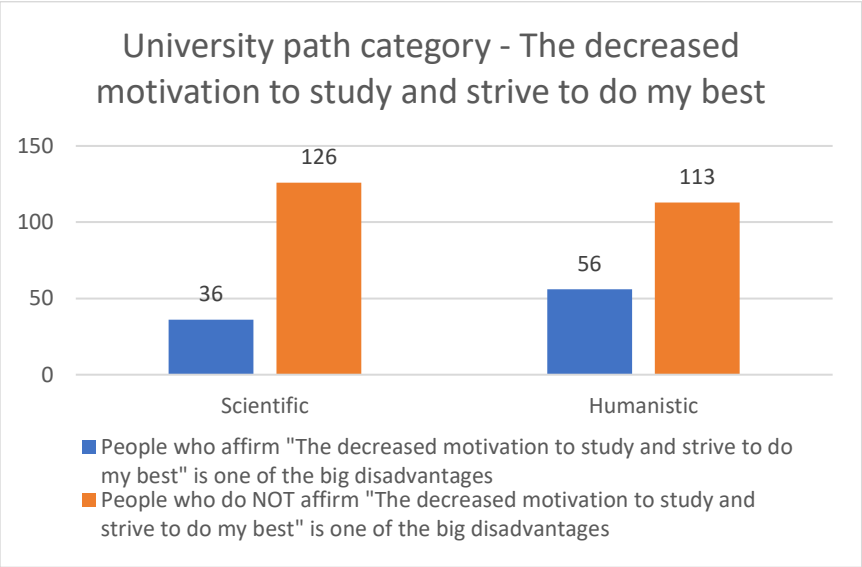


Table 105: Results for University path category - Motivation to study

Looking at the graph, what can be seen is an opposite trend to that hypothesized. Among students in scientific faculties, 22% selected this disadvantage, while among students in humanities faculties we reach the percentage of 33%.

Using Excel, the following calculations for the Chi-squares test have been conducted:

OBSERVED (O)			
	People who affirm "The decreased motivation to study and strive to do my best" is one of the big disadvantages	People who do NOT affirm "The decreased motivation to study and strive to do my best" is one of the big disadvantages	
Scientific	36	126	162
Humanistic	56	113	169
	92	239	331

EXPECTED (E)		
	People who affirm "The decreased motivation to study and strive to do my best" is one of the big disadvantages	People who do NOT affirm "The decreased motivation to study and strive to do my best" is one of the big disadvantages
Scientific	45,03	116,97
Humanistic	46,97	122,03

$(O-E)^2/E$		
	People who affirm "The decreased motivation to study and strive to do my best" is one of the big disadvantages	People who do NOT affirm "The decreased motivation to study and strive to do my best" is one of the big disadvantages
Scientific	1,81	0,70
Humanistic	1,73	0,67

X^2	4,91
df	1
p-value	0,03

Table 106: Chi-squares test for homogeneity - Motivation to study for University path category

As can easily be seen, the p-value is 0.02, so it is lower than the alpha level 0.05. There is a significant difference between the clusters in the University path category.

For extreme confirmation the test of the comparison of two population proportion can also be carried out. Using excel, the calculations obtained are as follows:

	H0	**p1-p2 = 0**	
	H1	**p1-p2 ≠ 0**	
1 = Scientific	p1	0,22	
2 = Humanistic	p2	0,33	
	Var1	0,00	
	Var2	0,00	
	alpha	0,05	
	Z	-2,24	NOT included between (-1,96;1,96)
	p-value	0,025	

Table 107: Comparison of two population proportion for University path category - Motivation to study

Again, the p-value is less than 0.05, so it confirms the result of the test done previously. The null hypothesis is rejected, accepting the alternative hypothesis.

Rejecting the null hypothesis in favor of the alternative hypothesis, we can therefore say that the frequency with which students who attend humanistic courses selected as one of the major disadvantages of the dad "The decreased motivation to study and strive to do my best" is greater than the cluster of students who attend scientific courses.

It is interesting now to see if there are also significant differences within the ***External environment category***.

In fact, it is possible that differences could be found between the two clusters in that again a condition that is not conducive to studying could lead to greater difficulty in attending classes, which would then result in a poor quality of learning that would more easily lead students to throw in the towel and lose motivation in studying.

The External environment category has the following characteristics:

- the question is a qualitative question;
- the category in question contains two clusters of students (students with an optimal external environment and students with a NOT optimal external environment).

The appropriate statistical test for the purpose is the Chi-squares test for Homogeneity. Below the null hypothesis and the alternative hypothesis that were set for the test.

External environment Category	
H0	H1
The proportion of students who reported one of the big weaknesses of distance learning is "The decreased motivation to study and strive to do my best" is the SAME among people who have an optimal external environment and who have not.	The proportion of students who reported one of the big weaknesses of distance learning is "The decreased motivation to study and strive to do my best" is DIFFERENT among people who have an optimal external environment and who have not.

Table 108: H0 and H1 for External environment category – Motivation to study

In the graph below it is possible to see the results of the responses divided between the two clusters.

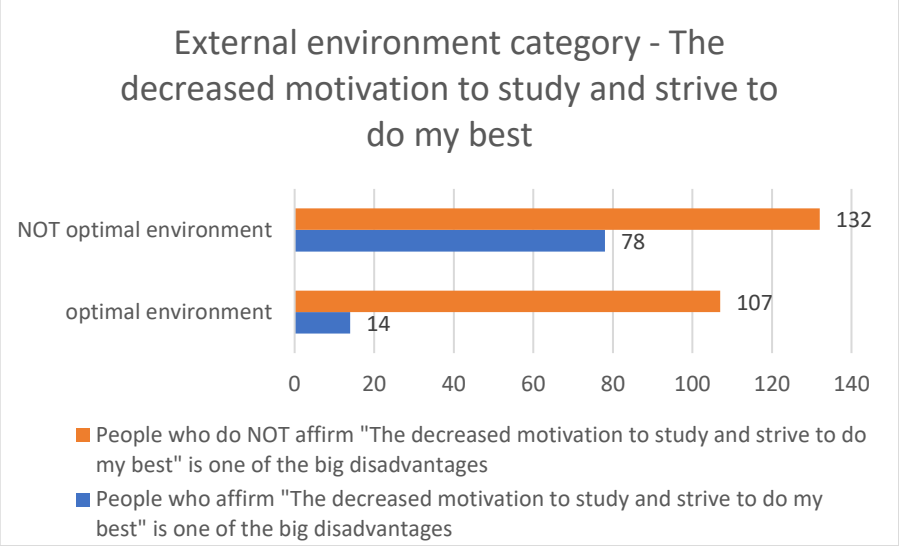


Table 109: Results for External environment category - Motivation to study

Looking at the graph, it is immediately possible to see that the difference between the two clusters is high: in fact, among students living in an optimal external environment only 11% of them reported "The decreased motivation to study and strive to do my best" while among students NOT living in an optimal external environment the percentage is 37%.

Using Excel, the following calculations for the Chi-squares test have been conducted:

OBSERVED (O)			
	People who affirm "The decreased motivation to study and strive to do my best" is one of the big disadvantages	People who do NOT affirm "The decreased motivation to study and strive to do my best" is one of the big disadvantages	
optimal environment	14	107	121
NOT optimal environment	78	132	210
	92	239	331

EXPECTED (E)		
	People who affirm "The decreased motivation to study and strive to do my best" is one of the big disadvantages	People who do NOT affirm "The decreased motivation to study and strive to do my best" is one of the big disadvantages
optimal environment	33,63	87,37
NOT optimal environment	58,37	151,63

$(O-E)^2/E$		
	People who affirm "The decreased motivation to study and strive to do my best" is one of the big disadvantages	People who do NOT affirm "The decreased motivation to study and strive to do my best" is one of the big disadvantages
optimal environment	11,46	4,41
NOT optimal environment	6,60	2,54

X^2	25,01
df	1
p-value	0,00

Table 110: Chi-squares test for homogeneity - Motivation to study for External environment category

As can easily be seen, the p-value is approximately 0, so it is lower than the alpha level 0.05. There is a significant difference between the clusters in the External environment category. In this case the null hypothesis has to be rejected in favor of the alternative hypothesis.

For extreme confirmation the test of the comparison of two population proportion can also be carried out. Using excel, the calculations obtained are as follows:

	H0	**p1-p2 = 0**	
	H1	**p1-p2 ≠ 0**	
1 = Optimal environment	p1	0,12	
2 = NOT optimal environment	p2	0,37	
	Var1	0,00	
	Var2	0,00	
	alpha	0,05	
	Z	-5,78	NOT included between (-1,96;1,96)
	p-value	0	

Table 111: Comparison of two population proportion for External environment category - Motivation to study

Again, the p-value is less than 0.05, so it confirms the result of the test done previously. The null hypothesis is rejected, accepting the alternative hypothesis.

5.2.2.3. The fact that my relationships with my colleagues has changed: I have felt more alone

Let us now analyze another really highly rated disadvantage "The fact that my relationships with my colleagues has changed: I have felt more alone"

In this case I do not expect a significant difference within the ***University size Category***, since, in situations of complete distance education, whatever the size of the university's students are always very isolated and contacts reduced as much as possible. However, it is good to check.

The University size category has the following characteristics:

- the question is a qualitative question;

- the category in question contains two clusters of students (students attending large, medium or small universities).

The appropriate statistical test for the purpose is the Chi-squares test for Homogeneity. Below the null hypothesis and the alternative hypothesis that were set for the test.

University size Category	
H0	H1
The proportion of students who reported one of the greatest strengths of distance learning is "The fact that my relationships with my colleagues has changed: I have felt more alone" is the SAME among people who are attending large, medium or small universities	The proportion of students who reported one of the greatest strengths of distance learning is "The fact that my relationships with my colleagues has changed: I have felt more alone" is DIFFERENT among people who are attending large, medium or small universities

Table 112: H0 and H1 for University size category –Changes in relationships

In the graph below it is possible to see the results of the responses divided between the three clusters.

The three categories (small - medium and large universities) selected the answer "The fact that my relationships with my colleagues has changed: I have felt more alone" with a frequency of 41%, 56% and 49% respectively.

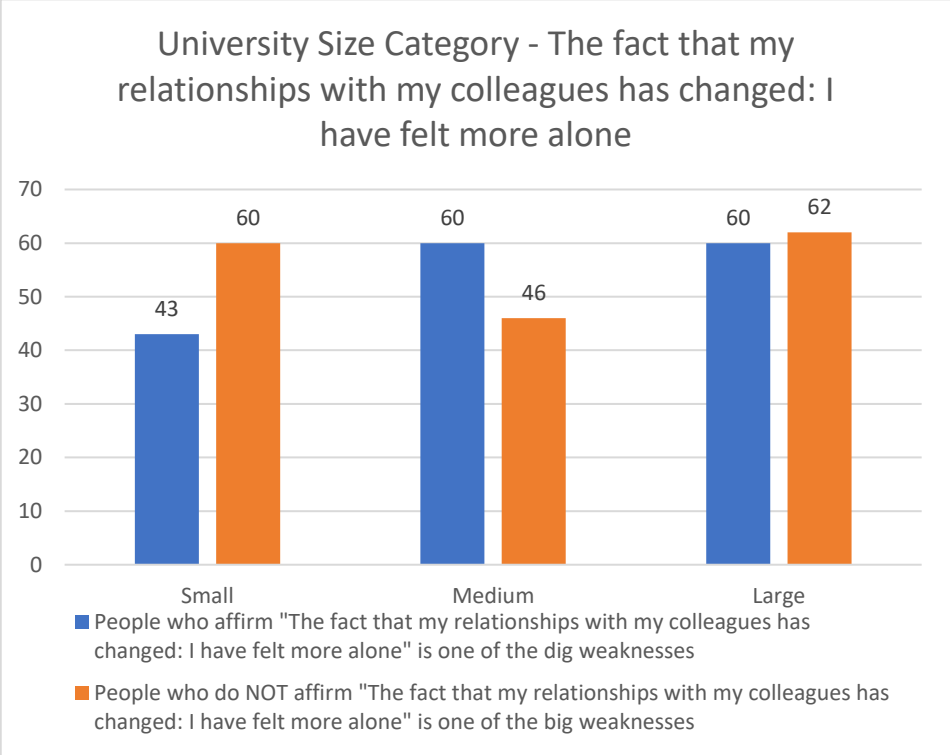
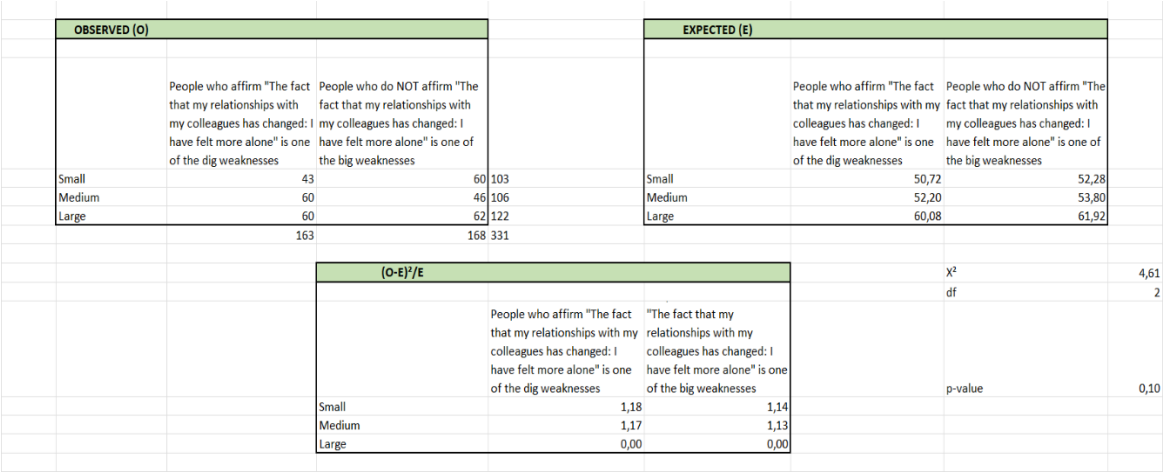


Table 113: Results for University size category - Changes in relationships

Therefore, it could be that there is actually a difference among the three categories. Let us perform the calculations to understand if it is statistically significant. Using Excel, the following calculations for the Chi-squares test have been conducted:



OBSERVED (O)

	People who affirm "The fact that my relationships with my colleagues has changed: I have felt more alone" is one of the dig weaknesses	People who do NOT affirm "The fact that my relationships with my colleagues has changed: I have felt more alone" is one of the big weaknesses	
Small	43	60	103
Medium	60	46	106
Large	60	62	122
	163	168	331

EXPECTED (E)

	People who affirm "The fact that my relationships with my colleagues has changed: I have felt more alone" is one of the dig weaknesses	People who do NOT affirm "The fact that my relationships with my colleagues has changed: I have felt more alone" is one of the big weaknesses
Small	50,72	52,28
Medium	52,20	53,80
Large	60,08	61,92

$(O-E)^2/E$

	People who affirm "The fact that my relationships with my colleagues has changed: I have felt more alone" is one of the dig weaknesses	"The fact that my relationships with my colleagues has changed: I have felt more alone" is one of the big weaknesses
Small	1,18	1,14
Medium	1,17	1,13
Large	0,00	0,00

X^2	4,61
df	2
p-value	0,10

Table 114: Chi-squares test for homogeneity - Changes in relationships for University size category

By performing the test, the p-value is 0.099, so it is greater than alpha (0.05), therefore, the null hypothesis cannot be rejected.

Therefore, we can conclude that among students that attend Lage, medium or small universities, no substantial difference was found and the conclusion is that the differences are consistent with being explained by sampling error. We can accept the initial hypothesis.

5.2.2.4. Lower quality of teaching

As the last part of the weaknesses analysis, the writer thinks it is important to analyze the response "**Lower quality of teaching**", which was selected 80 times.

Indeed, I would like to understand whether there is a significant difference between the frequency of the answers given within the ***External environment category***.

The hypothesis is that it may be that lower quality of education has been found among people who do not enjoy an optimal external environment. This, however, would lead one to think that it is not actually the quality of online teaching that is actually worse than in-presence teaching, but it is the suboptimal environment in which students find themselves lecturing that causes them to perceive a worse quality of teaching.

The External environment category has the following characteristics:

- the question is a qualitative question;
- the category in question contains two clusters of students (students attending a science-based degree program and students attending a humanities-based degree program).

The appropriate statistical test for the purpose is the Chi-squares test for Homogeneity. Below the null hypothesis and the alternative hypothesis that were set for the test.

External environment Category	
H0	H1
The proportion of students who reported one of the big weaknesses of distance learning is “Lower quality of teaching” is the SAME among people who have an optimal external environment and who have not.	The proportion of students who reported one of the big weaknesses of distance learning is “Lower quality of teaching” is DIFFERENT among people who have an optimal external environment and who have not.

Table 115: H0 and H1 for External environment category –Lower quality of teaching

In the graph below it is possible to see the results of the responses divided between the two clusters. The two categories (NOT optimal external environment – optimal external environment) selected the answer "Lower quality of teaching" with a frequency of 28% and 17% respectively. So there is some difference which with calculations in excel we will go to see whether it is significant or not.

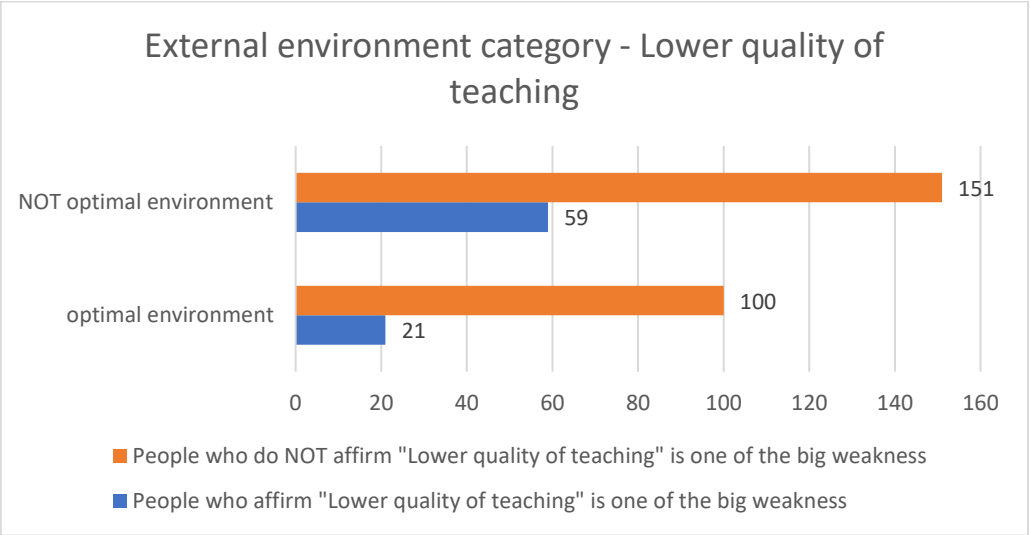


Table 116: Results for External environment category - Lower quality of teaching

Using Excel, the following calculations for the Chi-squares test have been conducted:

OBSERVED (O)

	People who affirm "Lower quality of teaching" is one of the big weakness	People who do NOT affirm "Lower quality of teaching" is one of the big weakness	
optimal environment	21	100	121
NOT optimal environment	59	151	210
	80	251	331

EXPECTED (E)

	People who affirm "Lower quality of teaching" is one of the big weakness	People who do NOT affirm "Lower quality of teaching" is one of the big weakness
optimal environment	29,24	91,76
NOT optimal environment	50,76	159,24

$(O-E)^2/E$

	People who affirm "Lower quality of teaching" is one of the big weakness	People who do NOT affirm "Lower quality of teaching" is one of the big weakness
optimal environment	2,32	0,74
NOT optimal environment	1,34	0,43

X^2	4,83
df	1
p-value	0,03

Table 117: Chi-squares test for homogeneity - Lower quality teaching for External environment category

As can easily be seen, the p-value is 0.027, so it is lower than the alpha level 0.05. There is a significant difference between the clusters in the External environment category. In this case the null hypothesis has to be rejected in favor of the alternative hypothesis.

For extreme confirmation the test of the comparison of two population proportion can also be carried out. Using excel, the calculations obtained are as follows:

	H0	**p1-p2 = 0**	
	H1	**p1-p2 ≠ 0**	
1 = Optimal environment	p1	0,17	
2 = NOT optimal environment	p2	0,28	
	Var1	0,001	
	Var2	0,001	
	Z	-2,32	NOT included between (-1,96;1,96)
	p-value	0,0208	

Table 118: Comparison of two population proportion for External environment category - Lower quality of teaching

Again, the p-value is less than 0.05, so it confirms the result of the test done previously. The null hypothesis is rejected, accepting the alternative hypothesis.

It may therefore be true that a worse quality of teaching is perceived in case external environment is not optimal.

5.2.3. OVERALL - Major differences from the pre-pandemic situation

At this point it is possible to sum up what are the major differences that were found through the survey within the various categories.

The main points analyzed are:

- Quality of online learning;
- Ease in keeping up with classes during distance learning;
- Great strengths of distance learning;
- Big weaknesses of distance learning.

First, at the beginning of the analysis, it could be seen that Italian students registered a degree of NOT AGREEING with the statement " **After taking classes in distance learning, I feel less ready for exams than when I took in-person (pre-pandemic)**".

In fact, there was no difference in mean on the Likert scale between the clusters of the various categories analyzed. Thus, we can say that Italian students predominantly disagreed (level 2 of the Likert scale) with the statement "After taking classes in distance learning, I feel less ready for exams than when I took in-person (pre-pandemic)."

This is a very important point because it gives us a very important piece of information: distance education succeeds in providing students with an average degree of exam preparation that is not inferior to traditional education.

This can benefit everyone, as we can see distance learning as something that can complement traditional education in the post-pandemic that we are experiencing.

Continuing the analysis, we moved on to study the responses given to the statement "**By taking the courses in distance learning I am able to keep up with the lessons of the courses more than when I was taking in-person (pre-pandemic)**".

Even in this case, there was no difference in mean on the Likert scale between the clusters of the various categories analyzed. Thus, we can say that Italian students predominantly agreed (level 3 of the Likert scale) with the statement "By taking the courses in distance learning I am able to keep up with the lessons of the courses more than when I was taking in-person (pre-pandemic)".

This result goes to reinforce what has been said above, namely the fact that not only is distance education not qualitatively inferior when we take into consideration preparation for exams, but even can be a valuable tool, if used well, to help students stay more on top of their classes and thus not find themselves having to study everything at the last minute.

At this point, the writer moved on to analyze what were the **major advantages** encountered by Italian students during distance education.

Certainly, the absolute most voted advantage was "Saving time spent traveling" with an impressive 277 votes. It means that of the 331 students surveyed, 83% of them see it as a major strength.

The writer deepened the analysis to see if within the university path category there is a significant difference in the frequency of responses between the two clusters (humanities students - science students). This test was created because many humanistic faculty often have mandatory attendance to take the exam. Therefore, it was hypothesized that students in humanities colleges selected the strength "Saving time spent traveling" significantly more frequently than students that attends scientific faculties. This hypothesis was rejected by the statistical tests conducted, as they found no significant difference in the distribution between the two clusters.

Continuing the analysis on strength "Saving time spent traveling" the writer assessed whether there was a significant difference in the frequency of responses among the clusters of the Geographical Category. In fact, it was hypothesized that people attending universities in southern Italy had listed "Saving time spent traveling" among the major strengths with a higher frequency than students attending universities in central or northern Italy. The hypothesis was made on the basis that southern Italy has less efficient public transportation in many areas than northern Italy. Indeed, this hypothesis could be true, as among students from southern Italian universities there was a frequency of 94% in selecting as one of the major strengths "Saving time spent traveling". This frequency was significantly different from those recorded for central and northern Italy.

After that, the analysis was continued by studying the strength "Take advantage of certain educational programs without incurring the costs of a non-resident student". It was

hypothesized that among students attending universities in northern Italy there is a higher frequency than in the other two geographical areas of people who voted "Take advantage of certain educational programs without incurring the costs of a non-resident student" as one of the major strengths of distance education. This was hypothesized on the basis that the central and northern Italy regions are home to a large number of out-of-resident students (1 in 3 students residing in southern italy study away from home, plus only Emilia Romagna and Lombardy boast 36% of Italy's out-of-resident students) and during the pandemic period many chose to return to live in their city of residence so as to cut costs.

It was actually seen that from what emerges from the responses given to the questionnaire, the percentages of responses containing the strength "Take advantage of certain educational programs without incurring the costs of a non-resident student" for clusters belonging to the Geographical Category are very similar to each other and all three are around 40%. Through statistical tests we confirm the fact that we do not actually find significant differences in the frequency of votes to the strength "Take advantage of certain educational programs without incurring the costs of a non-resident student" among the three clusters involved. The reason could be that even if South of Italy is the zone with more students that move to another region to go study, it is also true that there are many students (also from all Italian regions) who even if they do not change regions to go study, still move to the city where the university is located because it would not be possible to commute every day. This type of student has also benefited therefore from the lowered costs of being away from home, thus creating very similar response frequency rates among the three areas of Italy.

At this point in the analysis, it was thought to analyze another of the main advantages of distance learning that were highlighted by students: "The possibility of staying home on days when it would have been more complicated to get to the university (ex: weather conditions)". This was also a highly rated strength; in fact, it received 244 votes out of 331 participants. Therefore, the writer wanted to see if there were any differences in the frequency of responses among those belonging to the three different clusters of the geographical category. Indeed, it was hypothesized that people studying at universities located in northern Italy were more likely to select "The possibility of staying home on days when it would have been more complicated to get to the university (ex: weather conditions)" as one of the major strengths than those attending universities in central or southern Italy. This is because of the harsher climate that characterizes northern Italy.

In fact, by conducting the tests, it was seen that there is a significant difference between students in northern Italy and students in the south and center. But this difference has an opposite character to what was initially hypothesized. It was seen that 65% of people attending universities in northern italy entered "The possibility of staying home on days when it would have been more complicated to get to the university (ex: weather conditions)" among the major strengths, while for central and southern Italy we have a percentage of 85% and 80% respectively. Through the statistical test implemented it was seen that the difference between North vs. South and North vs. Center is statistically significant. This could be given by the fact that although the weather is worse in Northern

Italy, the fact that transportation works better than in Southern and Central Italy means that despite bad weather for students from Northern Italy it is not overly complicated to reach the university.

The last popular strength analyzed is "Flexibility in the use of video-recorded lessons" which received 241 votes out of 331.

It was intended to go to see if there is a significant difference within the University Path Category. In fact, it was hypothesized that science students voted more frequently for this strength because the subjects that are covered are often full of exercises, demonstrations, and theorems so it is very convenient to have video-recorded lectures that they can watch when needed. However, looking at the results of the statistical tests shows that there is absolutely no difference between the clusters in the university path category. This may be given by the fact that video-recorded lectures are convenient for everyone anyway.

At this point, the writer has focused on studying what the **main weaknesses** of distance education are and what inferences she can draw from them. To better analyze the disadvantages, the writer thought it is appropriate to include a new category in the analysis: the external environment category.

The analysis of major disadvantages starts from the very popular answer (voted by 176 people out of 331) "The greater ease in getting distracted and losing focus during class".

Although it was noted in the question " By taking the courses in distance learning I am able to keep up with the lessons of the courses more than when I was taking in-person" that people mostly agreed with the statement, however, the most voted disadvantage was just " The greater ease in getting distracted and losing focus during class". Thus, it could be concluded that although people are able to stay more in tune with classes through online education, it is also true that more than 50& of the survey respondents said they are more easily distracted following online classes than following traditional classes.

It was interesting to see the result that came out of the analysis of the external environment category. In fact, it was seen that the percentage of people who listed "The greater ease in getting distracted and losing focus during class " as one of the major disadvantages of distance education differed by more than 20% between the two clusters involved: NOT optimal environment 61%; optimal environment 40%.

In fact, it has been hypothesized that the occurrence of the condition of greater ease in becoming distracted and losing concentration is a consequence of the fact that there is a not insignificant segment of people who do not enjoy optimal external conditions that are therefore not favoring active class attendance. Running the tests showed that the difference between the two clusters is indeed statistically significant.

The next weakness analyzed was "The decreased motivation to study and strive to do my best" which received 92 votes out of 331. This is a very sensitive weakness because it involves people's psychological sphere. The past data is by no means to be underestimated, because as much as distance education can bring multiple advantages and benefits, it must

be remembered that if almost 30% of students reported seeing their motivation decrease, surely there is something that needs to be improved.

This weakness was analyzed from the perspective of both the University path category and the External environment category.

Starting with the first one, it was initially assumed that a science pathway, given its inherent difficulty, might lead to greater student demotivation during distance education than a humanities pathway. From the findings, however, it was seen that this is not the case, in fact, quite the opposite. The humanities cluster found a rate of 33%, while the science cluster found a rate of 22%, which were shown to be statistically different. So, the trend turned out to be contrary to what was hypothesized.

Continuing the weakness analysis "The decreased motivation to study and strive to do my best" by studying the effects of the category external environment, it was hypothesized that an unfavorable external condition leads to greater demotivation as the student finds it more difficult to attend classes, which translates into greater difficulty in coping with university and everything that goes with it.

Taking the tests further, it was seen that indeed there is a substantial difference between the two clusters: optimal environment 11%; NOT optimal environment 37%. This creates a huge gap between the two types of students, which can thus confirm the initial hypothesis.

At this point the analysis was continued by studying another of the main weaknesses found: "The fact that my relationships with my colleagues has changed: I have felt more alone" 163 out of 331 students voted it as one of the major weaknesses. This also absolutely should not be underestimated as it involves the psychological sphere of students.

In this case, it was hypothesized that there is no difference between students attending large, small and medium-sized universities, as in pandemic, being locked up at home students were completely isolated and the size of the university attended does not change much. Indeed, performing the calculations, no significant differences were found among the three clusters, this sets the stage for accepting the initial hypothesis.

The last among the major weaknesses that was analyzed is "Lower quality of teaching" This found 80 votes out of 331. This is an important figure, especially when compared with the fact that on average people agreed with the " After taking classes in distance learning, I feel less ready for exams than when I took in-person" statement analyzed above. So why did this result come together anyway? It was hypothesized that although the result of courses taught through distance learning does not turn out to be of lower quality for exam preparation, it must be said that the experience in taking individual classes may be more or less difficult depending on the external environment one finds oneself in. This may result in the fact that students perceive a lower quality of teaching that is given, however, precisely by factors external to the university and the professor teaching the course.

Analyzing the data collected for the external environment category, it was seen that indeed there is a significant difference in the proportion of people who voted "Lower quality of

teaching" as one of the major weaknesses between the two clusters involved, so the initial hypothesis could be true. The optimal environment cluster recorded a 17% voting the weakness "", while the NON optimal environment cluster recorded a 28%.

5.3.The most effective teaching methods for students

The second main pillar this thesis wants to understand which are the most effective teaching methods for students.

It is extremely important to highlight that it is not easy to arrive at an answer with certainty, as students' perceptions change depending on several factors, some among them may be:

- Students' predisposition toward types of teaching rather than others;
- The professors' ability to engage students;
- The external environment in which students live;
- The faculty they attend;
- The topics of the course being taken;
- The personality of the students.

5.3.1. Frontal teaching method

First, we are going to analyze all the questions regarding frontal type online teaching. Apparently, it is the easiest type of online teaching as it does not require special organization and inventiveness. The professor (optionally equipped with slides to be projected to better make students understand the topic) explains the lesson. All that is left for students to do is listen and try to take notes and learn as much as possible from the professor's words.

5.3.1.1. Frontal teaching involvement

The first question the writer wants to address concerns student involvement during frontal teaching. Specifically, the question is: "**During frontal lectures in distance learning, I often feel poorly involved**"

In fact, it is commonly believed that online classes are often very boring and difficult to follow. With the analysis to this question, let us see how true this statement is from the point of view of frontal online teaching.

Assuming that there is no significant difference between the clusters inside the ***University path category***, it is good to conduct the specific tests to confirm or reject this hypothesis.

Given that:

- the question is a Likert scale;

- the category in question contains two clusters of students (students attending a science-based degree program and students attending a humanities-based degree program).

The appropriate statistical test for the purpose is the t-test. Below the null hypothesis and the alternative hypothesis that were set for the test.

University Path Category	
H0	H1
There is NO difference in likert scale mean between students that attend scientific path and students that attend humanistic path	There is a difference in likert scale mean between students that attend scientific path and students that attend humanistic path

Table 119: H0 and H1 for University path category –Frontal teaching involvement

In the graph below it is possible to see the results of the responses divided between the two clusters.

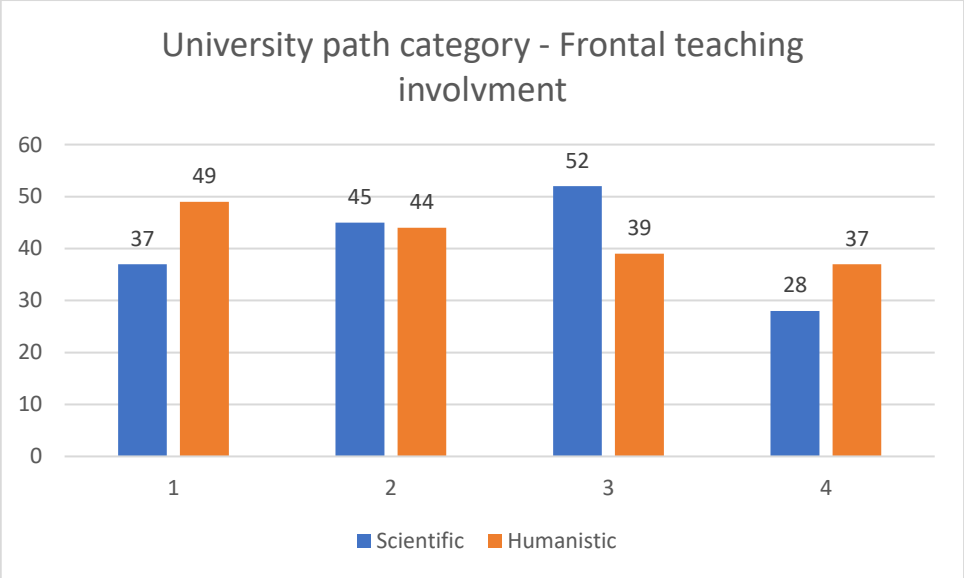


Table 120: Results for University path category - Frontal teaching involvement

It is immediate to note from the graph that the proportions of responses between the two clusters are quite similar.

Using the excel tool, the following information about the t-test conducted can be obtained:

University Path Category

Scientific - Humanistic t-Test: Two-Sample Assuming Equal Variances

	Scientific	*Humanistic*
Mean	2,44	2,38
Variance	1,06	1,26
Observations	162	169

Pooled Variance	1,16	
Hypothesized Mean Difference	0	
df	329	
t Stat	0,50	
P(T<=t) one-tail	0,31	
t Critical one-tail	1,65	
P(T<=t) two-tail	0,62	> 0,05
t Critical two-tail	1,97	

Table 121: t-test - Frontal teaching involvement for University path category

It is possible to see that the averages between the two clusters are very similar. By performing the test, the p-value two tail is indeed found to be greater than alpha (0.05), therefore, the null hypothesis cannot be rejected.

Therefore, we can conclude that among scientific path students and humanistic path students, no substantial difference was found between the Likert scale responses to the statement "During frontal lectures in distance learning, I often feel poorly involved".

In general, it is possible to see that the average of the responses is around 2,4 so approximating it to 2, it's a "Do not really agree" for both clusters.

In this case it is also interesting to see if there are some differences within the ***External environment category.***

In fact, it is hypothesized that just as with the perception of educational quality, there may be differences between those who enjoy an excellent external environment and those who do not.

Given that:

- the question is a Likert scale;
- the category in question contains two clusters of students (students with an optimal external environment and students without an optimal external environment).

The appropriate statistical test for the purpose is the t-test. Below the null hypothesis and the alternative hypothesis that were set for the test.

External environment Category	
H0	H1
There is NO difference in Likert scale mean between students that have an optimal external environment and who don't have	There is a difference in Likert scale mean between students that have an optimal external environment and who don't have

Table 122: H0 and H1 for External environment category –Frontal teaching involvement

It is immediate to note from the graph that the proportions of responses between the two clusters are quite different. The peak for the optimal environment category is on 1, while the peak for NOT optimal environment is on 3.

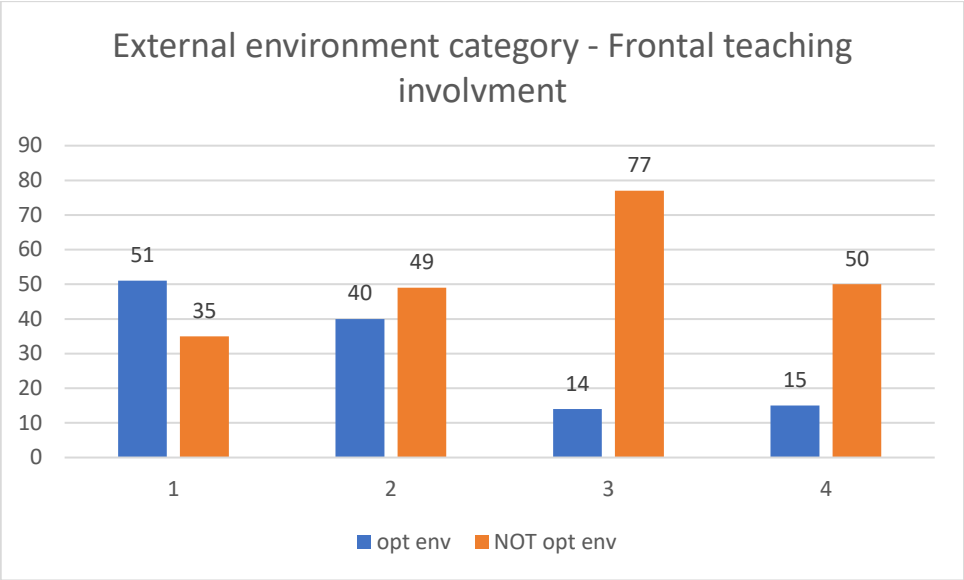


Table 123: Results for External environment category - Frontal teaching involvement

Using the excel tool, the following information about the t-test conducted can be obtained:

External environment Category

Optimal env - NOT optimal env | t-Test: Two-Sample Assuming Equal Variances

	Opt env	*NOT Opt env*	
Mean	1,94	2,67	
Variance	1,05	1,03	
Observations	120	211	
Pooled Variance	1,04		
Hypothesized Mean Difference	0		
df	329		
t Stat	-6,28		
P(T<=t) one-tail	0,00		
t Critical one-tail	1,65		
P(T<=t) two-tail	≈0		< 0,05
t Critical two-tail	1,97		

Table 124: t-test - Frontal teaching involvement for external environment category

It is possible to see that the averages between the two clusters are different. Approximating them we have: mean 2 for optimal environment and mean 3 for NOT optimal environment. By performing the test, the p-value two tail is indeed found to be lower than alpha (0.05), therefore, the alternative hypothesis is accepted.

Thus, there is a significant difference between the two clusters; in fact, the average sentiment for people with an optimal environment is to be "Do not really agree" with the sentence, while that of people with a NOT optimal environment is "Quite agree".

Thus, there is a significant difference between the two clusters; in fact, the average sentiment for people with an optimal environment is to be "Do not really agree" with the

sentence, while that of people with a NOT optimal environment is "Quite agree." Thus, there is disagreement for the first cluster and agreement for the second cluster. This lays the groundwork to be able to say that indeed the initial hypothesis might be correct, because since there is this significant difference between the two clusters, the discriminant might be the external environment.

An unsupportive outdoor environment does not help concentration and thus could increase the distance already present, making students feel less involved.

5.3.1.2. Frontal teaching method: assimilation of contents

The second question the writer wants to analyze concerns the students' capacity in assimilating contents from lectures conducted with the online frontal teaching method. Specifically, the question is: **"During the lessons in distance learning with frontal modality I assimilate better the concepts in comparison to when I attended the lessons with the same approach in presence (pre-pandemic)"**

Again, it is interesting to see whether there was a difference in responses between students in science and humanities faculties.

Assuming that there is no significant difference between the clusters inside the ***University path category***, it is good to conduct the specific tests to confirm or reject this hypothesis.

Given that:

- the question is a Likert scale;
- the category in question contains two clusters of students (students attending a science-based degree program and students attending a humanities-based degree program).

The appropriate statistical test for the purpose is the t-test. Below the null hypothesis and the alternative hypothesis that were set for the test.

University Path Category	
H0	H1
There is NO difference in likert scale mean between students that attend scientific path and students that attend humanistic path	There is a difference in likert scale mean between students that attend scientific path and students that attend humanistic path

Table 125: H0 and H1 for University path category – Frontal teaching method: assimilation of contents

In the graph below it is possible to see the results of the responses divided between the two clusters. It is immediate to note from the graph that the proportions of responses between the two clusters are quite similar.

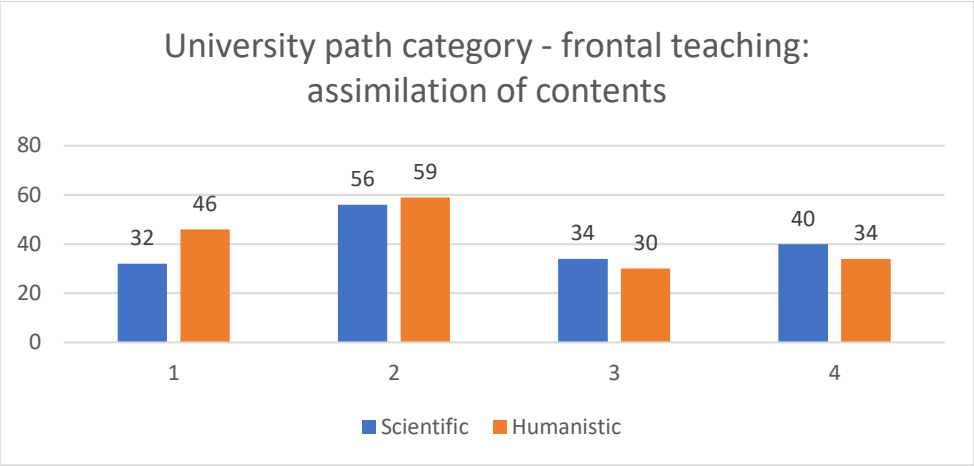


Table 126: Results for University path category - Frontal teaching method: assimilation of contents

Using the excel tool, the following information about the t-test conducted can be obtained:

University Path Category

Scientific - Humanistic | t-Test: Two-Sample Assuming Equal Variances

	Scientific	**Humanistic**	
Mean	2,51	2,31	
Variance	1,15	1,17	
Observations	162	169	
Pooled Variance	1,16		
Hypothesized Mean Difference	0		
df	329		
t Stat	1,68		
P(T<=t) one-tail	0,05		
t Critical one-tail	1,65		
P(T<=t) two-tail	0,09		> 0,05
t Critical two-tail	1,97		

Table 127: t-test - Frontal teaching method: assimilation of contents

It is possible to see that the averages between the two clusters are very similar. By performing the test, the p-value two tail is indeed found to be greater than alpha (0.05), therefore, the null hypothesis cannot be rejected.

Therefore, we can conclude that among scientific path students and humanistic path students, no substantial difference was found between the Likert scale responses to the statement "During the lessons in distance learning with frontal modality I assimilate better the concepts in comparison to when I attended the lessons with the same approach in presence (pre-pandemic)".

In general, it is possible to see that the average of the responses is around 2,4 so approximating it to 2, it's a "Do not really agree" for both clusters.

We can conclude by saying that the collective sentiment of Italian students is that online lectures succeed in giving no less preparation for exams than in-person lectures.

5.3.1.3. Frontal teaching method: Sense of loneliness

Among the major weaknesses of distance education with frontal modality it was noted that as many as 84 people said they feel more solitary when following lessons with this education modality. it is a large number, considering that it involves 1/4 of the people interviewed.

Let us then see if there are any significant differences within the ***University path category*** regarding the answer "**The sense of loneliness that one can often feel**".

Assuming that there are no significant differences, we then conduct the necessary analysis to be sure that this is indeed true.

The ***University Path category*** has the following characteristics:

- the question is a qualitative question;
- the category in question contains two clusters of students (students attending a science-based degree program and students attending a humanities-based degree program).

The appropriate statistical test for the purpose is the Chi-squares test for Homogeneity. Below the null hypothesis and the alternative hypothesis that were set for the test.

Homogeneity. Below the null hypothesis and the alternative hypothesis that were set for the test.

University Path Category	
H0	H1
The proportion of students who reported one of the big disadvantages of distance learning is “The sense of loneliness that one can often feel” is the SAME among people who are attending a scientific or humanistic universities	The proportion of students who reported one of the big disadvantages of distance learning is “The sense of loneliness that one can often feel” is DIFFERENT among people who are attending a scientific or humanistic universities

Table 128: H0 and H1 for University path category –Frontal teaching method: Sense of loneliness

In the graph below it is possible to see the results of the responses divided between the two clusters.

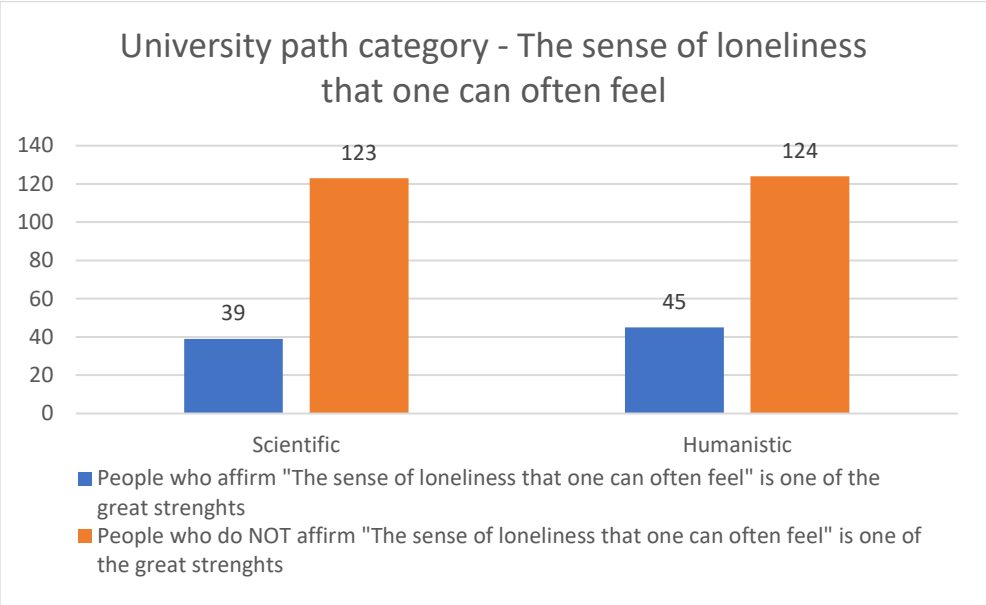


Table 129: Results for University path category - Frontal teaching method: Sense of loneliness

Looking at the graph, it is possible to see that the two clusters have very similar proportion. Among students in scientific faculties, 24% selected this disadvantage, while among students in humanities faculties we reach the percentage of 27%.

Using Excel, the following calculations for the Chi-squares test have been conducted:

OBSERVED (O)			
	People who affirm "The sense of loneliness that one can often feel" is one of the great strenghts	People who do NOT affirm "The sense of loneliness that one can often feel" is one of the great strenghts	
Scientific	39	123	162
Humanistic	45	124	169
	84	247	331

EXPECTED (E)		
	People who affirm "The sense of loneliness that one can often feel" is one of the great strenghts	People who do NOT affirm "The sense of loneliness that one can often feel" is one of the great strenghts
Scientific	41,11	120,89
Humanistic	42,89	126,11

$(O-E)^2/E$		
	People who affirm "The sense of loneliness that one can often feel" is one of the great strenghts	People who do NOT affirm "The sense of loneliness that one can often feel" is one of the great strenghts
Scientific	0,11	0,04
Humanistic	0,10	0,04

X^2	0,28
df	1
p-value	0,59

Table 130: Chi-squares test for homogeneity - Frontal teaching method: Sense of loneliness for University path category

By performing the test, the p-value is found to be greater than alpha (0.05), therefore, the null hypothesis cannot be rejected.

For extreme confirmation the test of the comparison of two population proportion can also be carried out. Using excel, the calculations obtained are as follows:

	H0	**p1-p2 = 0**	
	H1	**p1-p2 ≠ 0**	
1 = Scientific	p1	0,24	
2 = Humanistic	p2	0,27	
	Var1	0,001	
	Var2	0,001	
	alpha	0,05	
	Z	-0,53	included between (-1,96;1,96)
	p-value	0,60	

Table 131: Comparison of two population proportion for University path category - Frontal teaching method: Sense of loneliness

Again, the p-value is greater than 0.05, so it confirms the result of the test done previously. The alternative hypothesis is rejected, accepting the null hypothesis.

Therefore, we can conclude that among scientific path students and humanistic path students, no substantial difference was found and the conclusion is that the differences are consistent with being explained by sampling error.

5.3.2. Alternative teaching methods

At this point it is interesting to analyze what answers and conclusions we can draw from the questions regarding alternative education.

As seen in Chapter 2, the questions asked about it are the same for each type of alternative teaching. This was done so that we could put them on the same level and see if indeed among them there is any that is more preferred than the others by Italian students.

Each question regarding alternative teaching was analyzed from the perspective of the three fixed categories:

- University path category;
- Geographical category;
- University size category.

This was done to see if there were any substantial differences in the responses.

What could be found for all types of alternative education is that there are no statistically significant relevant differences between the various clusters of the categories analyzed. All types of alternative education were able to score high on all questions asked.

It is very interesting to note especially that all alternative teaching methods have found a great ability to reduce the distance between students and professors, this brings several benefits at the psychological level that are not insignificant.

Furthermore, it emerged from the analysis that this benefit brings with it other benefits including:

- The fact of feeling part of a group, thus experiencing a context in which one feels more involved and stimulated to do more for oneself and for the group to which one belongs;
- The fact that one can assimilate course concepts in a better way than in frontal online teaching.

It is very peculiar that all questions regarding alternative methods of distance education, regardless of the categories analyzed, scored very high. In fact, all clusters analyzed scored averages >= 3 out of 4 items on the Likert scale. This gives the fact that all the alternative teaching methods that were analyzed in this thesis work represent an added value to the lectures and teaching experience.

Interestingly, the question "*I believe that the <Alternative teaching method> is an effective way to best learn the concepts of many college courses in distance learning*" also found a large degree of agreement among students. This stands to show that all the teaching methods analyzed turn out to be extremely versatile for students.

The only distance teaching methodology that performed slightly worse than the others is Peer-to-peer learning relative to question "*During the lessons in distance learning with "flipped classroom" mode I quickly assimilate the concepts* ". The mean response for all clusters always approximated 2 - Quite agree. Below the graph with all the answers:

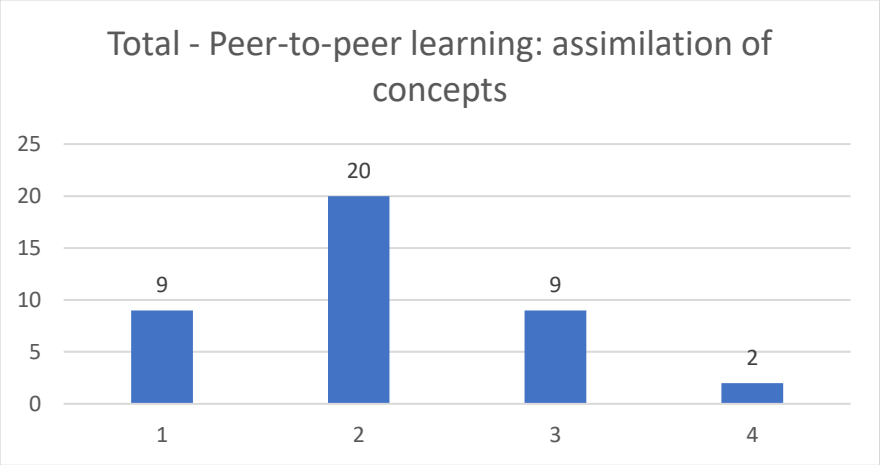


Table 132: Results for Peer to peer learning: assimilation of concepts

Conducting the one sample t-test on all respondents to the survey, we set the following hypotheses (null and alternative):

Total Category	
H0	H1
There is NO significant difference between the values of the sample, compared with the value 2 – Do not really agree	There is a significant difference between the values of the sample, compared with the value 2 – Do not really agree

Table 133: H0 and H1 for Total category – Peer to peer learning: assimilation of concepts

Calculating through MS Excel the one sample t-test - two-tailed analysis, the outcome is the following:

ONE SAMPLE T TEST	
Mean	2,1
Standard deviation	0,81
Count	40
Standard error of mean	0,13
Degrees of freedom	39
Hypotized mean	2
	-
t-statistic	0,78
p-value	0,44

Table 134: One sample t-test - Total category - Peer to Peer learning: assimilation of concepts

The p-value is 0.44 and the alpha level is set at 0.05, so the p-value is grater the alpha level. I cannot reject the null hypothesis.

This is probably due to the fact that students often do not have the same lecture skills as teachers, and it may therefore be somewhat less immediate for their "peers" to immediately catch on the concepts explained. Moreover, for one student, another student may not have the same credibility that a professor would have instead. Unconsciously one might therefore be a little more diffident and consequently less likely to pay attention.

This leads us to understand that indeed Italian students, in general, greatly appreciate alternative didactics during online classes, as probably by making them more engaged, more involved and more responsible for the work done, they are able to enjoy more of the educational experience which, even if it is limited due to social distancing, is enriched by simple elements but able to capture their attention.

5.3.3. Teaching methods - Preferences

Among people who responded that they had experienced alternative education, it was found that their preferences to the question "***Taking an overall analysis of the courses in distance learning that you have taken, you preferred***" were as follows:

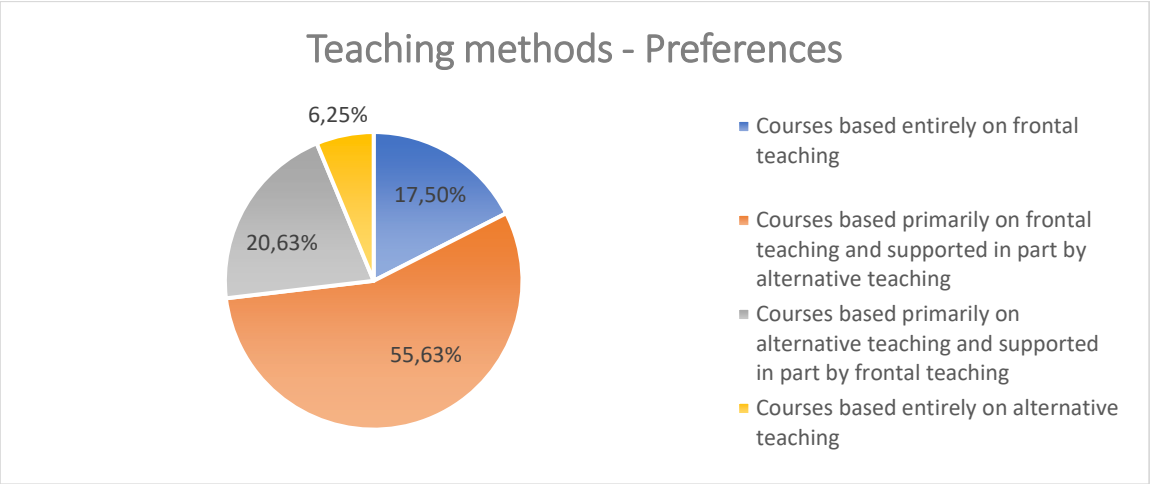


Table 135: Results for Teaching methods students' preferences (students who tried both frontal teaching method and alternative teaching methods)

As can be easily seen, the statements in the previous paragraph are backed up by this graph, as it is possible to see how alternative didactics achieved (in its various forms) a total of 81% approval ratings.

Obviously, students are not all the same and there are those who prefer a very high degree of alternative didactics in university courses and those who prefer it less predominantly and only as an adjunct to frontal teaching. We can also say that 55% of the students surveyed, or more than half said they preferred courses based primarily on frontal teaching and supported in part by alternative teaching.

Regarding those who prefer online classes conducted exclusively with frontal teaching, it was analyzed whether within the University path category there is a significant difference between the clusters.

The University Path Category has the following characteristics:

- the question is a qualitative question;
- the category in question contains two clusters of students (students attending a science-based degree program and students attending a humanities-based degree program).

The appropriate statistical test for the purpose is the Chi-squares test for Homogeneity. Below the null hypothesis and the alternative hypothesis that were set for the test.

University Path Category	
H0	H1
The proportion of students who reported they prefer “courses based entirely on frontal teaching” is the SAME among people who are attending a scientific or humanistic universities	The proportion of students who reported they prefer “courses based entirely on frontal teaching” is DIFFERENT among people who are attending a scientific or humanistic universities

Table 136: H0 and H1 for University path category – Teaching methods students' preferences

In the graph below it is possible to see the results of the responses divided between the two clusters.

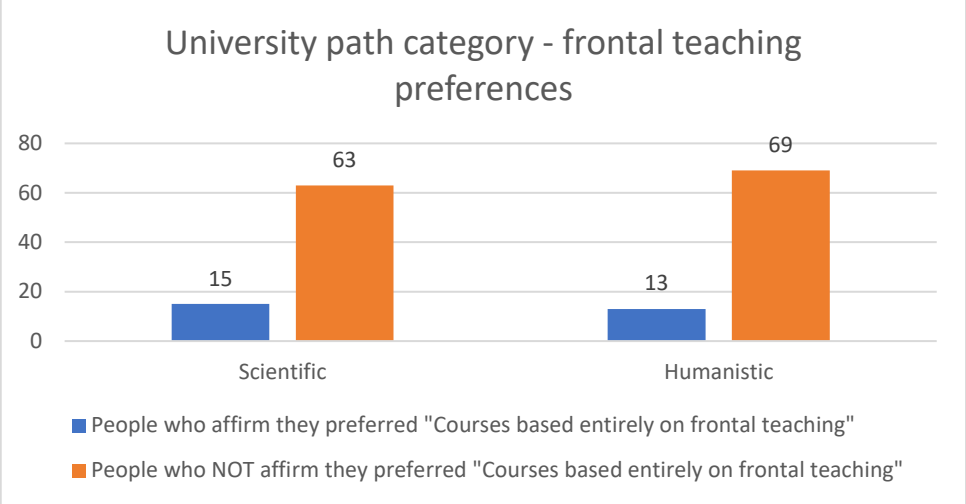


Table 137: Results for University path category - Teaching methods students' preferences

As can be seen from the graph, the proportions between the two clusters appear to be very similar.

Using Excel, the following calculations for the Chi-squeres test have been conducted:

OBSERVED (O)			
	People who affirm they preferred "Courses based entirely on frontal teaching"	People who NOT affirm they preferred "Courses based entirely on frontal teaching"	
Scientific	15	63	78
Humanistic	13	69	82
	28	132	160

EXPECTED (E)		
	People who affirm they preferred "Courses based entirely on frontal teaching"	People who NOT affirm they preferred "Courses based entirely on frontal teaching"
Scientific	13,65	64,35
Humanistic	14,35	67,65

$(O-E)^2/E$		
	People who affirm they preferred "Courses based entirely on frontal teaching"	People who NOT affirm they preferred "Courses based entirely on frontal teaching"
Scientific	0,13	0,03
Humanistic	0,13	0,03

X^2	0,32
df	1
p-value	0,57

Table 138: Chi-squares test for homogeneity - Teaching methods students' preferences for University path category

As can easily be seen, the p-value is higher than the alpha level 0.05. There is not a significant difference between the clusters in the University path category.

For extreme confirmation the test of the comparison of two population proportion can also be carried out. Using excel, the calculations obtained are as follows:

	H0	**p1-p2 = 0**	
	H1	**p1-p2 ≠ 0**	
1=Scientific	p1	0,19	
2=Humanistic	p2	0,16	
	Var1	0,00	
	Var2	0,00	
	Z	0,56	included between (-1,96;1,96)
	p-value	0,71	

Table 139: Comparison of two population proportion for University path category - Teaching methods students' preferences

Again, the p-value is greater than 0.05, so it confirms the result of the test done previously. The alternative hypothesis is rejected, accepting the null hypothesis.

5.3.4. OVERALL – The most effective teaching methods for students

Online teaching was obviously perceived differently by students than traditional teaching. That is why the responses of Italian students were collected. Through the questionnaire administered, in fact, an attempt was made to shed light on what was successful and what was not from the point of view of teaching during the pandemic.

First, it was seen that frontal teaching was used as the only method of teaching by 48% of the students surveyed. Thus, only about half of them had a chance to try other types of teaching besides the most classic one: frontal teaching.

Students' responses regarding frontal teaching showed that the question "**During frontal lectures in distance learning, I often feel poorly involved**" generated mixed responses. Within the university path category there were no significant differences between the two clusters, both of which scored an average approximating 2 - Do not really agree. Which is good, as science and humanities universities are not particularly different, and both did not resent with the negative effect highlighted overwhelmingly.

Note, however, that instead a different result was found within the external environment category. Indeed, it is seen that between the two clusters there is a significant difference found through the appropriate statistical test, which denotes that for the NOT optimal environment cluster the overall mean is 2,67 approximating to 3 – Quite agree, while for the optimal environment cluster the overall mean is 1,94 approximating to 2 – Do not really agree. Thus, once again, the environment plays a key role; the weight is so great that it turns out to be the determinant in making students feel less involved during lectures with frontal teaching.

On the other hand, with regard to the question **“During the lessons in distance learning with frontal modality I assimilate better the concepts in comparison to when I attended**

the lessons with the same approach in presence (pre-pandemic)" it is inferred that the 60% of respondents disagreed with the statement.

It was tried to see if there were any differences within the University path category, but both clusters were found to have responses that were roughly aligned, both averaging approximately 2 - Do not really agree. This gives us an important piece of information: for the majority of Italian students, online frontal teaching is no better than traditional frontal teaching (done in the presence).

Among the weaknesses found for distance frontal education, the most worrisome, as it touches on the psychological point of view of students: in fact, a quarter of them said they experience "**A sense of loneliness**" during lectures with online frontal teaching. An attempt was made to see if there were discordant results between the two clusters of the university path category, but this is not the case: the percentages of people who selected "The sense of loneliness that one can often feel" as answer to the major weaknesses for frontal distance learning for the science cluster and the humanities cluster is respectively: 24% and 27%.

Regarding **alternative teaching methodologies**, it was seen that only half of the students surveyed had the opportunity during the pandemic to experience alternative teaching. The result that came out of the analysis conducted on alternative teaching is very peculiar, as it was found through the appropriate statistical tests that students' sentiment on the various types of alternative teaching is very similar both among the various clusters of students and among the various types of alternative teaching.

Thus, it can be inferred that alternative online teaching is highly valued by Italian students as it allows them to overcome some of the limitations of frontal online teaching. The most encouraging finding was certainly the fact that all alternative teaching methods scored very well in agreement with the question ***"I believe the <Alternative teaching method> helps reduce the physical distance with colleagues and professors***". It is interesting also that alternative didactics, if done well and if it were more widespread in universities, might be able to break down the worrying fact on the sense of loneliness that students feel when taking online classes in frontal teaching mode. For completeness, the result is also reported here, which amounts to 1 in 4 students experienced this discomfort during the pandemic. In addition, alternative teaching has been found to be adaptable for students to almost any college course.

However, there is a point to be made: in fact, it was found that Peer-to-peer learning was rated with a lower degree of agreement than the other alternative teaching methods for the question "During the lessons in distance learning with "**Peer-to-peer learning**" mode I quickly assimilate the concepts", as it scored an overall mean of the entire sample analyzed of 2.1 out of 4 on the Likert scale. This may be given by the fact that a student does not have the same credibility as a professor in the eyes of another student. In addition, students themselves often do not have advanced teaching skills as many professors may have.

In conclusion, it must be said that the answers to the question "***Taking an overall analysis of the courses in distance learning that you have taken, you preferred:***" do not leave room for much doubt, as it was seen that 81% of the surveyed students prefer alternative teaching to be present (in whole or in part) in online university courses.

However, it is important to make a distinction: university courses taught with only alternative teaching were not found to be preferred by students (percentage amounts to 6%); rather, it was the frontal teaching courses accompanied by alternative teaching. This makes it possible to say that frontal teaching is by no means to be abandoned; on the contrary, it is still a valuable tool as it allows to explain precise concepts, information and notions that would otherwise be difficult to convey to students. Especially the less immediate and more abstruse concepts need a clear explanation from a competent person such as the professor.

It must be said, however, that it turned out that the right mix of alternative teaching and online teaching could be the best teaching method. It is also easily visible from the graph above that a mix between the two types of teaching is preferred by students, as 75% of them voted that they prefer either courses based on frontal teaching and supplemented with alternative teaching or vice versa.

This could be given by the following factors:

- It allows to overcome the limitations of teaching conducted exclusively in the frontal online mode. It is therefore successful in making students feel less lonely, engaging them and making learning active. They can be part of a group, thus experiencing a context in which one feels more involved and stimulated to do more for oneself and for the group to which one belongs;
- It allows the class to be guided by giving a general outline of what are the main and fundamental concepts of the course, leaving it then up to the students, through alternative teaching, to go into more details.

5.4.The exams during distance learning

We have come to the last part of this chapter: the part that deals with profit exams taken online. Let us then go to analyze what the responses were in order to draw conclusions and try to understand what methods are the most effective in order to have reliable results, what are the most popular methods of copying, and most importantly, if indeed there are significant differences between the truthfulness of the results obtained during in-person exams and exams taken online.

In order to succeed in this endeavor, there were many techniques put in place during the pandemic by professors to avoid having their students cheat.

In the following paragraphs, the following methods will be discussed:

- Use of proctoring tools (proctoring tools are based on artificial intelligence, that allows a student's device to be checked at exams or quizzes and capture as much data to decree if the student is cheating or not);

- Use of the dual camera, which allows for not only the frontal view of the student that one would normally have through the webcam, but also a side view that can fully capture the environment in which the student is immersed. This ensures that there are no "blind spots" or points where the student can freely move his or her hands using, for example, smartphones or notes that are not allowed.

5.4.1. Frequency of copying in online exams

At this point, it is interesting to see the changes in percentage of copiers for what regards online exams. There was a doubling in the number of people who reported that they often copied during online exams. Which is worrying, because this percentage, in the case of online exams stands at 8%, which means that almost 1 in 10 students copy very often during online exams. This is certainly a figure that gives one pause for thought since, if this mode is to be used in the post-pandemic period as well, surely it will have to be taken into consideration that student monitoring systems will have to be improved.

The percentage of people who reported cheating “few times” during online exams also increased a lot. In fact, this percentage increased from 25% (for in-person exams) to 42% (for online exams). This is also a worrying figure, as slightly less than 1 in 2 people have been found to have cheated during online exams.

Let us now see whether the same result found in the previous paragraph holds true, that is, whether the proportion of people who reported cheating during "very few time" online exams is statistically equal in the two clusters of the University path category.

The University Path category has the following characteristics:

- the question is a qualitative question;
- the category in question contains two clusters of students (students attending a science-based degree program and students attending a humanities-based degree program)

The appropriate statistical test for the purpose is the Chi-squares test for Homogeneity. Below the null hypothesis and the alternative hypothesis that were set for the test.

University Path Category	
H0	H1
The proportion of students who reported they have copied “very few times” in online exams is the SAME among people who are attending a scientific or humanistic universities	The proportion of students who reported they have copied “very few times” in online exams is DIFFERENT among people who are attending a scientific or humanistic universities

Table 140: H0 and H1 for University path category – Frequency of copying in online exams

In the graph below it is possible to see the results of the responses divided between the two clusters.

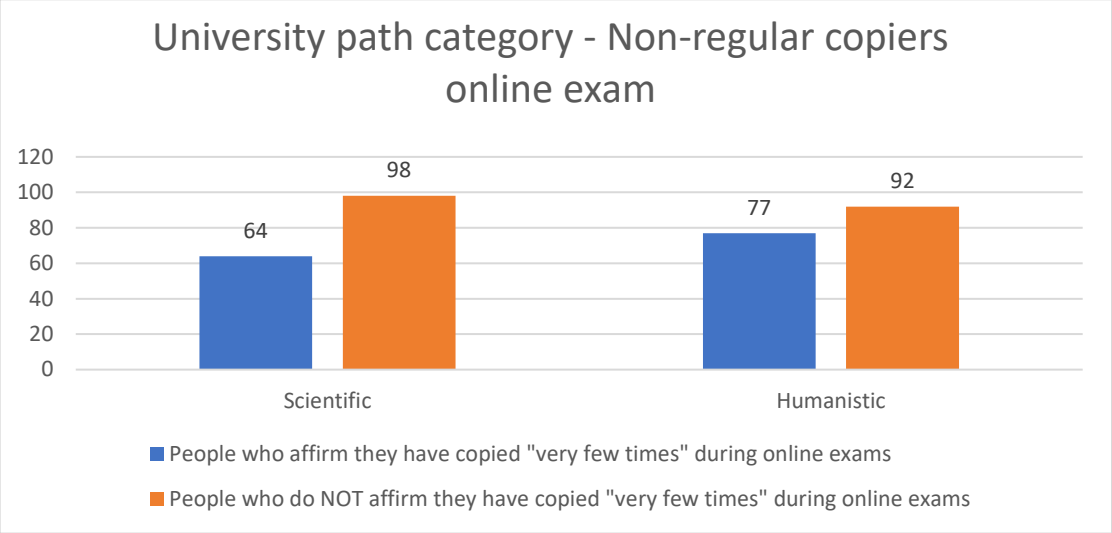


Table 141: Results for University path category - Frequency of copying in online exams

It can be seen from the graph that the percentage of students attending scientific universities who selected they cheated during in person exams “very few times” is 40%, while the percentage for students in humanistic universities is 46%. So, the proportions are quite similar and, in both clusters, incremented almost equally.

Using Excel, the following calculations for the Chi-squares test have been conducted.

OBSERVED (O)			
	People who affirm they have copied "very few times" during online exams	People who do NOT affirm they have copied "very few times" during online exams	
Scientific	64	98	162
Humanistic	77	92	169
	141	190	331

EXPECTED (E)		
	People who affirm they have copied "very few times" during online exams	People who do NOT affirm they have copied "very few times" during online exams
Scientific	69,01	92,99
Humanistic	71,99	97,01

(O-E)²/E		
	People who affirm they have copied "very few times" during online exams	People who do NOT affirm they have copied "very few times" during online exams
Scientific	0,36	0,27
Humanistic	0,35	0,26

X^2	1,24
df	1,00
p-value	0,27

Table 142: Chi-squares test for homogeneity - Frequency of copying in online exams for University path category

By performing the test, the p-value is found to be greater than alpha (0.05), therefore, the null hypothesis cannot be rejected.

For extreme confirmation the test of the comparison of two population proportion can also be carried out. Using excel, the calculations obtained are as follows:

	H0	**p1-p2 = 0**	
	H1	**p1-p2 ≠ 0**	
1 = Scientific	p1	0,40	
2 = Humanistic	p2	0,46	
	Var1	0,00	
	Var2	0,00	
	alpha	0,05	
	Z	-1,12	included between (-1,96;1,96)
	p-value	0,262	

Table 143: Comparison of two population proportion for University path category - Frequency of copying in online exams

Again, the p-value is greater than 0.05, so it confirms the result of the test done previously. The alternative hypothesis is rejected, accepting the null hypothesis.

Therefore, we can conclude that among scientific path students and humanistic path students, no substantial difference was found and the conclusion is that the differences are consistent with being explained by sampling error.

5.4.2. Frequency of copying in in-person exams

We begin by analyzing the question "***Have you ever cheated during an in-person (pre-pandemic) exam?***" Indeed, the goal is to try to find out whether within the ***University path category*** differences between clusters are present.

We hypothesize that students in science majors are more likely to cheat sporadically as they are subjected mainly to written examinations.
We immediately see that the percentage of people subject to frequent copying is really very low and is attested at 4%. Let us then analyze the frequency in the answer "Yes, very few times."

The University Path category has the following characteristics:

- the question is a qualitative question;
- the category in question contains two clusters of students (students attending a science-based degree program and students attending a humanities-based degree program).

The appropriate statistical test for the purpose is the Chi-squares test for Homogeneity. Below the null hypothesis and the alternative hypothesis that were set for the test.

University Path Category	
H0	H1

The proportion of students who reported they have copied “very few times” in in-person exams is the SAME among people who are attending a scientific or humanistic universities	The proportion of students who reported they have copied “very few times” in in-person exams is DIFFERENT among people who are attending a scientific or humanistic universities

Table 144: H0 and H1 for University path category – Frequency of copying in person exams

In the graph below it is possible to see the results of the responses divided between the two clusters.

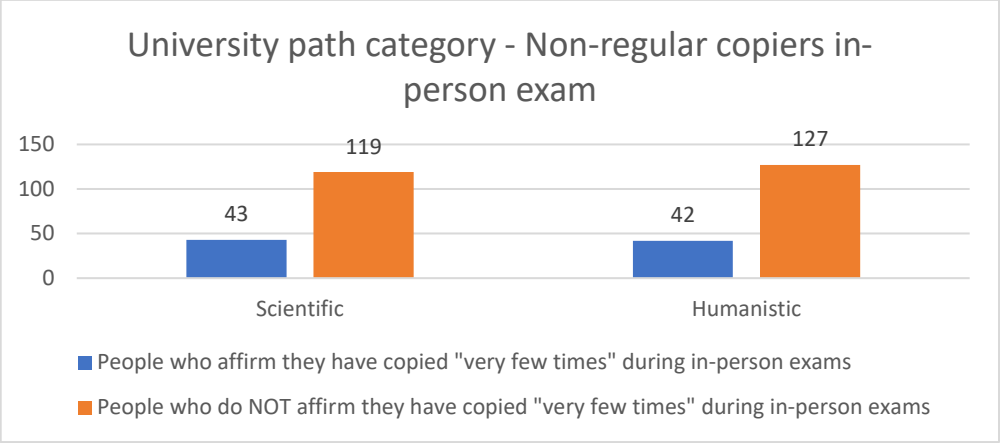


Table 145: Results for University path category - Frequency of copying in person exams

It can be seen from the graph that the percentage of students attending scientific universities who selected they cheated during in person exams “very few times” is 27%, while the percentage for students in humanistic universities is 25%. So the proportions are very similar.

Using Excel, the following calculations for the Chi-squares test have been conducted:

OBSERVED (O)			
	People who affirm they have copied "very few times" during in-person exams	People who do NOT affirm they have copied "very few times" during in-person exams	
Scientific	43	119	162
Humanistic	42	127	169
	85	246	331

EXPECTED (E)		
	People who affirm they have copied "very few times" during in-person exams	People who do NOT affirm they have copied "very few times" during in-person exams
Scientific	41,60	120,40
Humanistic	43,40	125,60

$(O-E)^2/E$		
	People who affirm they have copied "very few times" during in-person exams	People who do NOT affirm they have copied "very few times" during in-person exams
Scientific	0,05	0,02
Humanistic	0,05	0,02

X^2	0,12
df	1,00
p-value	0,72

Table 146: Chi-squares test for homogeneity - Frequency of copying in person exams for University path category

By performing the test, the p-value is found to be greater than alpha (0.05), therefore, the null hypothesis cannot be rejected.

For extreme confirmation the test of the comparison of two population proportion can also be carried out. Using excel, the calculations obtained are as follows:

	H0	**p1-p2 = 0**	
	H1	**p1-p2 ≠ 0**	
1 = Scientific	p1	0,27	
2 = Humanistic	p2	0,25	
	Var1	0,001	
	Var2	0,001	
	alpha	0,05	
	Z	0,35	included between (-1,96;1,96)
	p-value	0,728	

Table 147: Comparison of two population proportion for University path category - Frequency of copying in person exams

Again, the p-value is greater than 0.05, so it confirms the result of the test done previously. The alternative hypothesis is rejected, accepting the null hypothesis.

Therefore, we can conclude that among scientific path students and humanistic path students, no substantial difference was found, and the conclusion is that the differences are consistent with being explained by sampling error.

We can therefore say that the initial hypothesis that saw the scientific cluster as the one more inclined to copying is not true.

In general, we can say that there is no difference between the science cluster and the humanities cluster in terms of exams taken in attendance, as the copying rate is very

similar between them. In conclusion, 2/3 of students surveyed said they had never copied during an in-presence exam.

5.4.3. Use of proctoring tools

At this point in the analysis, it is interesting to analyze one of the two most famous methods of student control: the use of proctoring tools.

The respondents to the questionnaire also answered the question "**Were proctoring tools used to monitor student activities during exams?**". It is therefore interesting to see if there were differences in the frequency of use between small, medium and large universities, we will then go on to analyze the answers given for the ***University size category***.

Let us assume that medium and large universities are the ones that make the most use of proctoring tools. This is because these universities often have courses with large number of students that might be difficult to manage during exams.

For the following test, the proportions of students from small, medium and large universities who responded that they use proctoring tools very often during online exams versus students who said they never use proctoring tools during exams were compared.

The University size category has the following characteristics:

- the question is a qualitative question;
- the category in question contains two clusters of students (students attending large, medium or small universities).

The appropriate statistical test for the purpose is the Chi-squares test for Homogeneity. Below the null hypothesis and the alternative hypothesis that were set for the test.

University size Category	
H0	H1
The proportion of students who declared they often use proctoring tools during their exams is the SAME among people who are attending large, medium or small universities	The proportion of students who declared they often use proctoring tools during their exams is DIFFERENT among people who are attending large, medium or small universities

Table 148: H0 and H1 for University size category – Use of Proctoring tools

In the graph below it is possible to see the results of the responses divided between the three clusters.

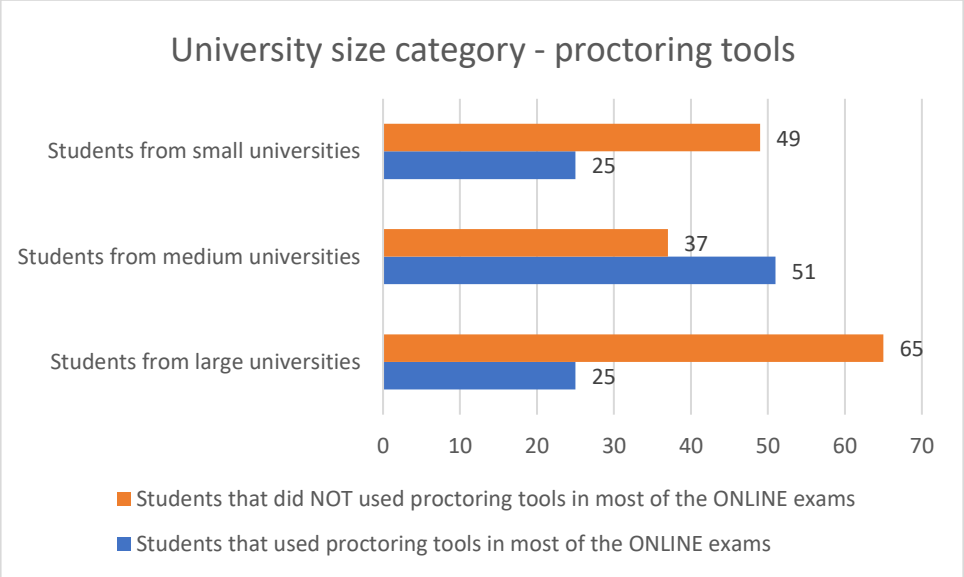


Table 149: Results for University size category - Proctoring tools

The three categories (small - medium and large universities) selected the answer "Yes, most teachers have made use of proctoring tools" with a frequency of 34%, 58% and 28% respectively. Already from the graph, therefore, there is a big difference between the three clusters in the responses. The central Italy cluster differs considerably from the other two. Therefore, it could be that there is a significant difference among the three categories. Let us perform the calculations to better understand this. Using Excel, the following calculations for the Chi-squares test have been conducted:

OBSERVED (O)			
	Students that used proctoring tools in most of the ONLINE exams	Students that did NOT used proctoring tools in most of the ONLINE exams	
Students from large universities	25	65	90
Students from medium universities	51	37	88
Students from small universities	25	49	74
	101	151	252

EXPECTED (E)		
	Students that used proctoring tools in most of the ONLINE exams	Students that did NOT used proctoring tools in most of the ONLINE exams
Students from large universities	36,07	53,93
Students from medium universities	35,27	52,73
Students from small universities	29,66	44,34

$(O-E)^2/E$		
	Students that used proctoring tools in most of the ONLINE exams	Students that did NOT used proctoring tools in most of the ONLINE exams
Students from large universities	3,40	2,27
Students from medium universities	7,02	4,69
Students from small universities	0,73	0,49

X^2	18,60	
df	2,00	(rows-1)*(columns-1)
p-value	0,0001	>0,05

Table 150: Chi-squares test for homogeneity - Use of proctoring tools for University size category

As can easily be seen, the p-value is almost 0, so it is lower than the alpha level 0.05. There is a significant difference between the clusters in the geographical category.

Comparing large universities with small universities by Chi-squares test, it can be easily seen that there are no significant differences, as the p-value is greater than 0.05.

OBSERVED (O)			
	Students that used proctoring tools in most of the ONLINE exams	Students that did NOT used proctoring tools in most of the ONLINE exams	
Students from large universities	25	65	90
Students from small universities	25	49	74
	50	114	164

EXPECTED (E)		
	Students that used proctoring tools in most of the ONLINE exams	Students that did NOT used proctoring tools in most of the ONLINE exams
Students from large universities	27,44	53,93
Students from small universities	29,66	44,34

$(O-E)^2/E$		
	Students that used proctoring tools in most of the ONLINE exams	Students that did NOT used proctoring tools in most of the ONLINE exams
Students from large universities	0,22	2,27
Students from small universities	0,73	0,49

X^2	3,71	
df	1,00	(rows-1)*(columns-1)
p-value	0,0541	>0,05

Table 151: Post-hoc test Chi-squares test for homogeneity - Use of proctoring tools for Clusters Large vs Small Universities

Looking instead at the tests done with the large VS medium and medium VS small pairs, the p-value is lower in both cases. This means that the proportion of students from medium universities who answered that in most of their online exams they used proctoring tools is significantly higher than that of students from the large and small universities of Italy.

OBSERVED (O)			
	Students that used proctoring tools in most of the ONLINE exams	Students that did NOT used proctoring tools in most of the ONLINE exams	
Students from medium universities	51	37	88
Students from small universities	25	49	74
	76	86	162

EXPECTED (E)		
	Students that used proctoring tools in most of the ONLINE exams	Students that did NOT used proctoring tools in most of the ONLINE exams
Students from medium universities	35,27	52,73
Students from small universities	29,66	44,34

$(O-E)^2/E$		
	Students that used proctoring tools in most of the ONLINE exams	Students that did NOT used proctoring tools in most of the ONLINE exams
Students from medium universities	7,02	4,69
Students from small universities	0,73	0,49

X^2	12,93	
df	1,00	(rows-1)*(columns-1)
p-value	0,0003	<0,05

Table 152: Post-hoc test Chi-squares test for homogeneity - Use of proctoring tools for Clusters Medium vs Small Universities

OBSERVED (O)			
	Students that used proctoring tools in most of the ONLINE exams	Students that did NOT used proctoring tools in most of the ONLINE exams	
Students from large universities	25	65	90
Students from medium universities	51	37	88
	76	102	178

EXPECTED (E)		
	Students that used proctoring tools in most of the ONLINE exams	Students that did NOT used proctoring tools in most of the ONLINE exams
Students from large universities	38,43	53,93
Students from medium universities	35,27	52,73

$(O-E)^2/E$		
	Students that used proctoring tools in most of the ONLINE exams	Students that did NOT used proctoring tools in most of the ONLINE exams
Students from large universities	4,69	2,27
Students from medium universities	7,02	4,69

X^2	18,67	
df	1,00	(rows-1)*(columns-1)
p-value	0,00002	<0,05

Table 153: Post-hoc test Chi-squares test for homogeneity - Use of proctoring tools for Clusters Large vs Medium Universities

Thus, the trend that can be seen is that medium-sized universities are the ones that have made the most use of proctoring tools.

At this point it is interesting to analyze whether within the ***University path category*** there are significant differences in the proportions between people who frequently use proctoring tools and those who do not.

In fact, we hypothesize that there is a significant difference between the two clusters with science students being greater users of proctoring tools as they are more subject than humanities students to written exams.

The University Path category has the following characteristics:

- the question is a qualitative question;
- the category in question contains two clusters of students (students attending a science-based degree program and students attending a humanities-based degree program).

The appropriate statistical test for the purpose is the Chi-squares test for Homogeneity. Below the null hypothesis and the alternative hypothesis that were set for the test.

University Path Category	
H0	H1
The proportion of students who declared they often use proctoring tools during their exams is the SAME among people who are attending science-based universities and humanities-based universities	The proportion of students who declared they often use proctoring tools during their exams is DIFFERENT among people who are attending science-based universities and humanities-based universities

Table 154: H0 and H1 for University path category – Use of Proctoring tools

In the graph below it is possible to see the results of the responses divided between the two clusters.

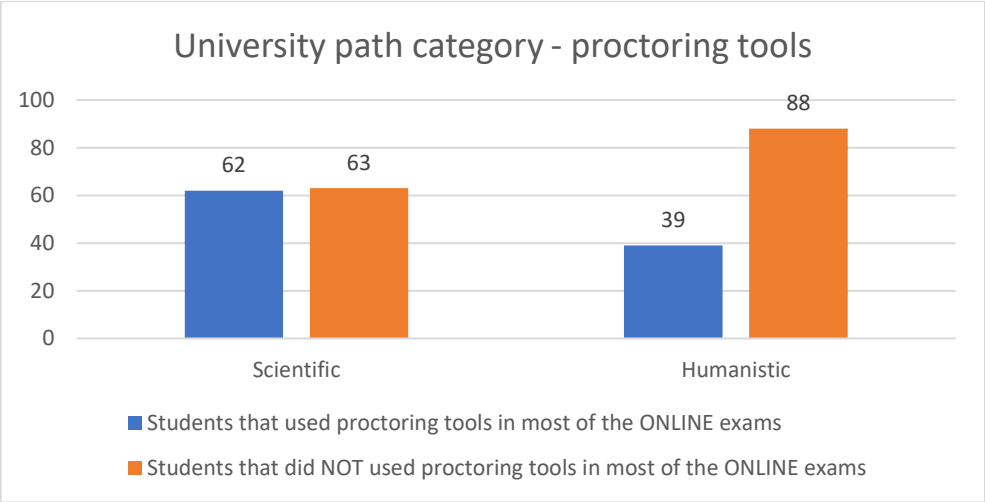


Table 155: Results for University path category - Proctoring tools

It can be seen from the graph that the percentage of students attending scientific universities who selected that they used proctoring tools is 50%, while the percentage for students in humanistic universities is 31%. So, the proportions are are quite different. Let us see if this difference is a statistically relevant difference.

Using Excel, the following calculations for the Chi-squares test have been conducted:

OBSERVED (O)			
	Students that used proctoring tools in most of the ONLINE exams	Students that did NOT used proctoring tools in most of the ONLINE exams	
Scientific	62	63	125
Humanistic	39	88	127
	101	151	252

EXPECTED (E)		
	Students that used proctoring tools in most of the ONLINE exams	Students that did NOT used proctoring tools in most of the ONLINE exams
Scientific	50,10	74,90
Humanistic	50,90	76,10

$(O-E)^2/E$		
	Students that used proctoring tools in most of the ONLINE exams	Students that did NOT used proctoring tools in most of the ONLINE exams
Scientific	2,83	1,89
Humanistic	2,78	1,86

X^2	9,36
df	1
p-value	0,002

Table 156: Chi-squares test for homogeneity - Use of proctoring tools for University path category

As can easily be seen, the p-value is 0.002, so it is lower than the alpha level 0.05. There is a significant difference between the clusters in the University path category.

For extreme confirmation the test of the comparison of two population proportion can also be carried out. Using excel, the calculations obtained are as follows:

	H0	**p1-p2 = 0**	
	H1	**p1-p2 ≠ 0**	
1 = Scientific	p1	0,50	
2 = Humanistic	p2	0,31	
	Var1	0,00	
	Var2	0,00	
	alpha	0,05	
	Z	3,12	NOT included between (-1,96;1,96)
	p-value	0,01	

Again, the p-value is less than 0.05, so it confirms the result of the test done previously. The null hypothesis is rejected, accepting the alternative hypothesis.

We can therefore accept to the initial hypothesis that saw science students as major users of proctoring tools.

5.4.4. Use of dual camera

At this point it is interesting to try to draw some analysis regarding the second method of monitoring students during exams mentioned above: the use of dual camera. For this reason, students were asked the following question: "**Have you ever taken an online exam where the prof required the use of dual cameras (to get side control of the student)?**".

As was done for the first method analyzed (the use of proctoring tools) it is useful to carry forward the analysis regarding the University size category and the ***University path category***. This is to see if indeed there are significant differences between the various clusters here as well.

Let us start from the analysis of the University size category and try to assume again that there is a significant difference: medium and large universities are the ones that make the most use of dual camera. This is because these universities often have courses with large number of students that might be difficult to manage during exams.

For the following test, the proportions of students from small, medium and large universities who responded that they use the dual camera very often during online exams versus students who said they never use dual camera during online exams were compared.

The University size category has the following characteristics:

- the question is a qualitative question;
- the category in question contains two clusters of students (students attending large, medium or small universities).

The appropriate statistical test for the purpose is the Chi-squares test for Homogeneity. Below the null hypothesis and the alternative hypothesis that were set for the test.

University size Category	
H0	H1
The proportion of students who declared they often use dual camera during their online exams is the SAME among people who are attending large, medium or small universities	The proportion of students who declared they often use dual camera during their online exams is DIFFERENT among people who are attending large, medium or small universities

Table 157: H0 and H1 for University size category – Use of dual camera

In the graph below it is possible to see the results of the responses divided between the three clusters.

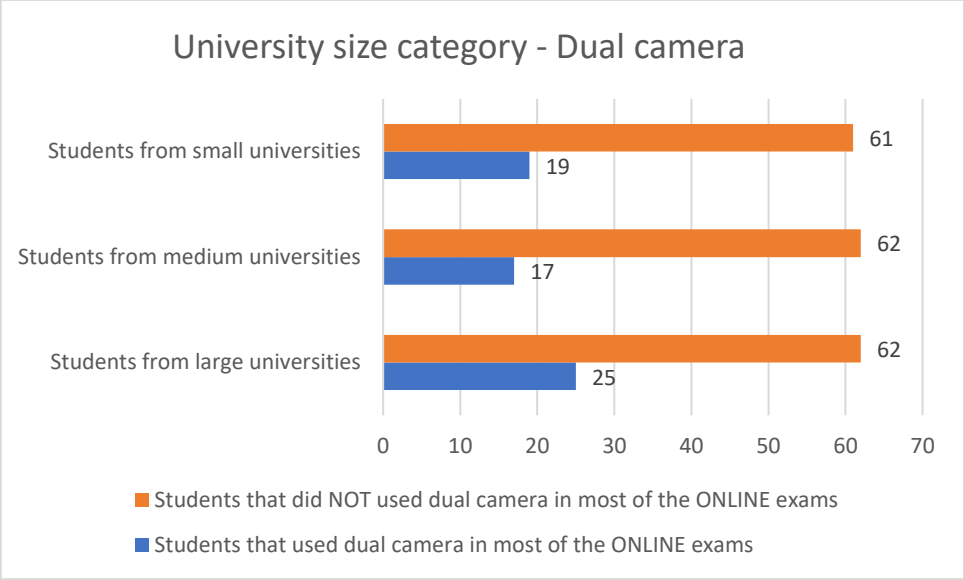


Table 158: Results for University size category - Use of dual camera

The three categories (small - medium and large universities) declared they frequently use the dual camera during online exams with a frequency of 23%, 21% and 29% respectively. All three percentages are close and quite low.
Excel, the following calculations for the Chi-squares test have been conducted:

OBSERVED (O)

	Students that used dual camera in most of the ONLINE exams	Students that did NOT used dual camera in most of the ONLINE exams	
Students from large universities	25	62	87
Students from medium universitie	17	62	79
Students from small universities	19	61	80
	61	185	246

EXPECTED (E)

	Students that used dual camera in most of the ONLINE exams	Students that did NOT used dual camera in most of the ONLINE exams
Students from large universities	21,57	65,43
Students from medium universiti	19,59	59,41
Students from small universities	19,84	60,16

$(O-E)^2/E$

	Students that used dual camera in most of the ONLINE exams	Students that did NOT used dual camera in most of the ONLINE exams
Students from large universities	0,54	0,18
Students from medium universiti	0,34	0,11
Students from small universities	0,04	0,01

X^2	1,23	
df	2,00	(rows-1)*(columns-1)
p-value	0,5417	>0,05

Table 159: Chi-squares test for homogeneity - Use of dual camera for University size category

By performing the test, the p-value is 0.54, so it is greater than alpha (0.05), therefore, the null hypothesis can not be rejected.

Therefore, we can conclude that among students that attend Lage, medium or small universities, no substantial difference was found and the conclusion is that the differences are consistent with being explained by sampling error. We can accept the initial hypothesis.

Therefore, we can conclude that within the University size category, no significant differences were found regarding dual camera use.

Let us now look at the ***University path category*** to see if significant differences can be found within it.

The University Path category has the following characteristics:

- the question is a qualitative question;
- the category in question contains two clusters of students (students attending a science-based degree program and students attending a humanities-based degree program).

The appropriate statistical test for the purpose is the Chi-squares test for Homogeneity. Below the null hypothesis and the alternative hypothesis that were set for the test.

University Path Category	
H0	H1
The proportion of students who declared they often use dual camera during their online exams is the SAME among people who are attending science-based universities and humanities-based universities	The proportion of students who declared they often use dual camera during their online exams is DIFFERENT among people who are attending science-based universities and humanities-based universities

Table 160: H0 and H1 for University path category – Use of dual camera

In the graph below it is possible to see the results of the responses divided between the two clusters.

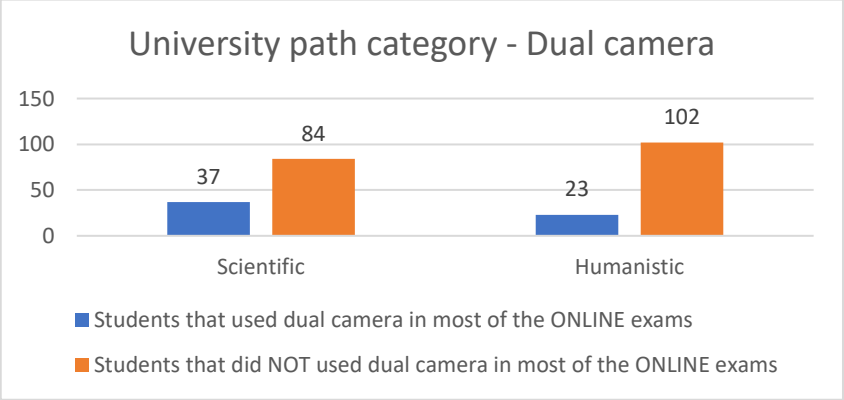


Table 161: Results for University path category - Use of dual camera

It can be seen from the graph that the percentage of students attending scientific universities who selected that they used proctoring tools is 31%, while the percentage for students in humanistic universities is 18%. So the proportions are are quite different. Let us see if this difference is a statistically relevant difference.

Using Excel the following calculations for the Chi-squares test have been conducted:

OBSERVED (O)			
	Students that used dual camera in most of the ONLINE exams	Students that did NOT used dual camera in most of the ONLINE exams	
Scientific	37	84	121
Humanistic	23	102	125
	60	186	246

EXPECTED (E)		
	Students that used dual camera in most of the ONLINE exams	Students that did NOT used dual camera in most of the ONLINE exams
Scientific	29,51	91,49
Humanistic	30,49	94,51

$(O-E)^2/E$		
	Students that used dual camera in most of the ONLINE exams	Students that did NOT used dual camera in most of the ONLINE exams
Scientific	1,90	0,61
Humanistic	1,84	0,59

X^2	4,94
df	1
p-value	0,026

Table 162: Chi-squares test for homogeneity - Use of dual camera for University path category

As can easily be seen, the p-value is 0.02, so it is lower than the alpha level 0.05. There is a significant difference between the clusters in the University path category.

For extreme confirmation the test of the comparison of two population proportion can also be carried out. Using excel, the calculations obtained are as follows:

	H0	**p1-p2 = 0**	
	H1	**p1-p2 ≠ 0**	
1 = Scientific	p1	0,31	
2 = Humanistic	p2	0,18	
	Var1	0,00	
	Var2	0,00	
	alpha	0,05	
	Z	2,24	NOT included between (-1,96;1,96)
	p-value	0,03	

Table 163: Comparison of two population proportion for University path category - Use of dual camera

Again, the p-value is less than 0.05, so it confirms the result of the test done previously. The null hypothesis is rejected, accepting the alternative hypothesis.

We can therefore say science students use the dual camera more frequently than humanistic students during online exams.

5.4.5. Ease in cheating during online exams

Let us now analyze the question "**I believe that cheating during online exams is easier than in-person exams**" to understand what the sentiment of Italian students is.

As seen in Chapter 2, responses to this question tended toward agreement with the statement with about 70% of people voting 3 or 4.

Next, let's look at whether people who stated that they routinely used the above-mentioned control methods (dual camera and proctoring) during online exams voted significantly differently than people who stated that they never use these types of student control tools.

At this point it is useful to create a new category: the **Proctoring category**. There are two clusters contained within it and they concern People who reported that they often use proctoring tools during online exams and People who reported that they do not use proctoring tools during online exams.

We hypothesize that students who habitually use proctoring tools voted with a medium degree of agreement the statement "I believe that cheating during online exams is easier than in-person exams", as the proctoring tool should be a strong disincentive in copying since one is constantly checked.

Given that:

- the question is a Likert scale;
- the category in question contains two clusters of students (students who reported that they often use proctoring tools during online exams - students who reported that they do not use proctoring tools during online exams).

The appropriate statistical test for the purpose is the t-test. Below the null hypothesis and the alternative hypothesis that were set for the test.

Proctoring Category	
H0	H1
There is NO difference in Likert scale mean between people who stated they often use proctoring tools and who not	There is a difference in Likert scale mean between people who stated they often use proctoring tools and who not

Table 164: H0 and H1 for Proctoring category – Ease in cheating during online exams

In the graph below it is possible to see the results of the responses divided between the two clusters. It is immediate to note from the graph that the proportions of responses between the two clusters are quite similar.

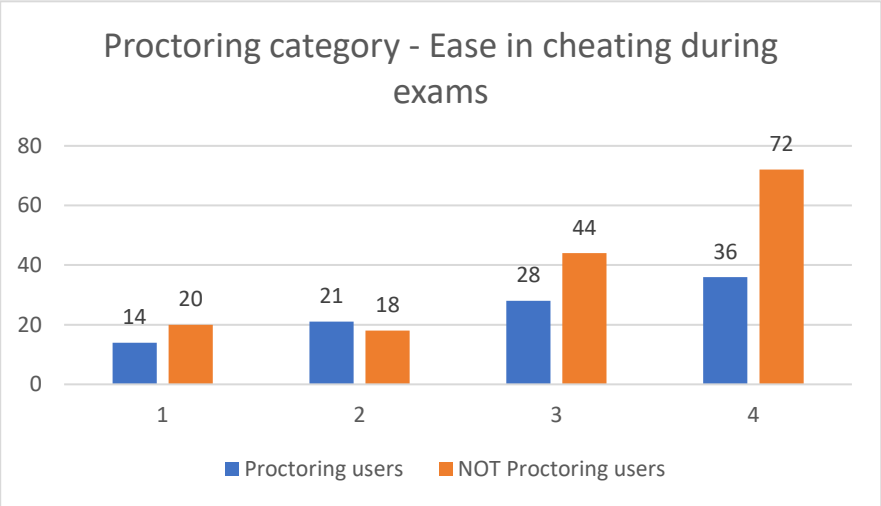


Table 165: Results for Proctoring category- Ease in cheating during online exams

Using the excel tool, the following information about the t-test conducted can be obtained:

Proctoring Category

Proctoring - NOT Proctoring users | t-Test: Two-Sample Assuming Equal Variances

	Proctoring	*NOT Proctoring*	
Mean	2,87	3,09	
Variance	1,14	1,10	
Observations	99,00	154,00	
Pooled Variance	1,12		
Hypothesized Mean Difference	0,00		
df	251,00		
t Stat	-1,63		
P(T<=t) one-tail	0,05		
t Critical one-tail	1,65		
P(T<=t) two-tail	0,10		> 0,05
t Critical two-tail	1,97		

Table 166: t-test - Ease in cheating for Proctoring category

It is possible to see that the averages between the two clusters are very similar. By performing the test, the p-value two tail is indeed found to be greater than alpha (0.05), therefore, the null hypothesis cannot be rejected.

It is therefore possible to say that no significant differences were found between the two clusters (the two means are both around 3). Thus, this implies that indeed both those who habitually use proctoring tools and those who do not on average think that copying during online exams is easier than copying during in-person exams.

This is probably due to the fact that the proctoring tool controls the student, but it mainly controls the face through the webcam, which often, if not placed at a high distance causes the student's hands to be completely uncontrolled. It may therefore be easier for students to use hidden notes or even electronic devices placed near the computer with which the exam is being taken.

At this point we continue the analysis of the answers to question "I believe that cheating during online exams is easier than in-person exams" by creating a new category to study: the **Dual camera category**.

We do the same thing done above, but this time for the ***Dual camera category***.
Indeed, we hypothesize that the use of a dual camera is a strong deterrent to copying since the teacher has full view of the environment surrounding the student.

Given that:

- the question is a Likert scale;
- the category in question contains two clusters of students (students who reported that they often use dual camera during online exams - students who reported that they do not use dual camera during online exams).

The appropriate statistical test for the purpose is the t-test. Below the null hypothesis and the alternative hypothesis that were set for the test.

Proctoring Category	
H0	H1
There is NO difference in Likert scale mean between people who stated they often use dual camera and who not	There is a difference in Likert scale mean between people who stated they often use dual camera and who not

Table 167: H0 and H1 for Dual Camera category – Ease in cheating during online exams

In the graph below it is possible to see the results of the responses divided between the two clusters. It is immediate to note from the graph that the proportions of responses between the two clusters are quite different. Let us then see if there is a significant difference between the two clusters.

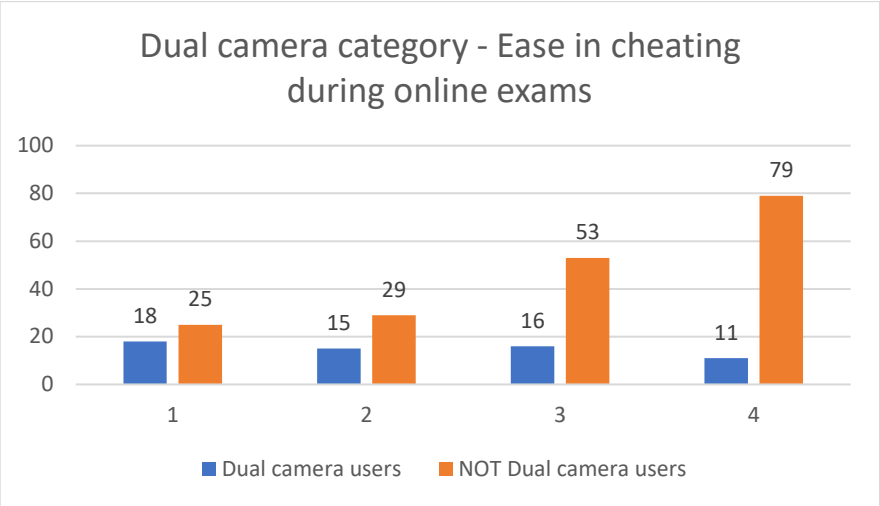


Table 168: Results for Dual Camera category - Ease in cheating during online exams

Using the excel tool, the following information about the t-test conducted can be obtained:

Dual camera Category	
Dual camera - Not dual camera users	t-Test: Two-Sample Assuming Equal Variances

	Dual camera	*NOT Dual camera*	
Mean	2,33	3,00	
Variance	1,21	1,12	
Observations	60,00	186,00	
Pooled Variance	1,14		
Hypothesized Mean Difference	0,00		
df	244,00		
t Stat	-4,20		
P(T<=t) one-tail	0,00		
t Critical one-tail	1,65		
P(T<=t) two-tail	0,00		<0,05
t Critical two-tail	1,97		

Table 169: t-test - Ease in cheating for Dual Camera category

By performing the test, the p-value two tail is indeed found to be almost 0, so lower than alpha (0.05), therefore, the null hypothesis cannot be accepted.

Thus, we can say that people in the Dual camera users cluster generated on average a response approximating 2 - Do not really agree. In contrast, people belonging to the NOT Dual camera users cluster generated an average response approximating 3 - Quite agree.

We then move from a degree of disagreement with the "I believe that cheating during online exams is easier than in-person exams" statement for dual camera to a degree of agreement for NOT Dual camera.

This indicates that the use of dual cameras can indeed be considered as a deterrent to copying. Probably, in fact, although the dual camera is obviously not equipped with artificial intelligence, it allows the teacher to have a complete view of what the student is doing during the exam. it is indeed possible to see all hand movements, where the student is laying his gaze, and whether the environment around him is emptied of all forbidden objects.

5.4.6. Most common methods to cheat during online exams

We conclude our analysis of the examination section of the questionnaire. The last two questions are aimed at finding out which methods are easiest for students to implement for both oral and written exams.

The result that came out is peculiar, as most of the methods, both in terms of oral and written examinations, would be easily avoided if dual cameras were used as control of the student.

In fact, as far as written in chapter 2 for **written exams**, it turned out that the two highest rated methods were "*"Carpeting" the environment behind the pc (and the pc itself) with papers containing course material*" and "*Using a cell phone or tablet outside of the camera's viewing range*". They alone accounted for 65% of the responses.

It can easily be seen that if the teacher has a total view of what is the environment in which the student is immersed these methods would be useless. Using the proctoring tool, on the other hand, even with due care, the student can easily put them into practice.

It has to be said, however, that the third highest rated mode is "*"Conceal" sheets containing course notes among the materials allowed to take the exam*." which would still be quite difficult to detect even with a dual camera, since, being positioned at a fair distance from the student in order to pick up everything around the student, it would not detect the notes among the papers on the desk.

However, this method could easily be ostracized if the teacher asked the student to show all the papers and notes he has with him, concurrently with the use of the dual camera, which would prevent him from taking other hidden papers later.

Turning instead to the copying methods for oral exams, we see that the second top-rated method was "*"Carpeting" the environment behind the pc (and the pc itself) with papers containing course material*". Thus, just as with what was said about written exams, this method can be easily thwarted by asking students to use the dual camera, or, given the immediacy of oral exams, it may also be sufficient to simply ask the student to show the entire environment around him or her on camera.

The other two top-rated methods were "Ask for “help from the audience” by having a colleague who is also watching the exam send you the answer to the question the professor

just asked" and "Keep the course material in a document in your PC and open it next to the web page where the exam is open" which scored 12% and 38% responses, respectively.
For these methods, the dual camera would not be sufficient, as it would not allow for seeing specifically what exactly the student is looking at on the pc. However, to hinder the use of this method of copying online exams, it might help to ask the student to share their computer screen during the exam, concurrently with the use of the dual camera to make sure that they do not have a second computer or phone from which to take the information for the exam.

5.4.7. OVERALL – The exams during distance learning

Summarizing what was said for online exams, it was seen that in general there was a considerable increase of people who reported cheating during online exams. Although most people reported copying "a few times" during online exams, this category amounted to 42% of the respondents. This is a significant number considering that it is about one in two people and that the same category is around 25% for in-person exams. In addition, people who said they often cheat amount to 8%. This data is doubling, considering that it was found that during the in-presence exams only 4% from declared that they copied often during the exams.

When asked "What do you think are the types of exams where it is easiest to cheat?" the absolute top-rated answer (with 71% of votes) was "written exams". Thus, it was initially assumed that the phenomenon of copying during online exams was more established among students of science faculties.
However, the initial theory has been disproved, as by making the comparison using the Chi-squares test there is no significant difference between science and humanities college students who reported copying during online exams. The same result was found by conducting tests for the same category on the in-person exams.

After that, one of the two methods of controlling students considered in this thesis paper was analyzed: the use of proctoring tools. It was seen that proctoring tools are more widely used in medium universities, the percentage of people studying in medium universities who stated that they often use proctoring tools during online exams is 58%, while for large and small universities it is 34% and 28%. The difference between medium and small - large universities turns out to be statistically significant. Also significant was the difference in the proportion of students from scientific universities who reported frequently using proctoring tools, compared with students from humanistic universities. In fact, we speak of 50% of students for science universities and 31% for humanities universities.

The same considerations were made for the dual camera method, which allows the teacher to have, in addition to the webcam footage, a side view of the student via another camera. In this case, it was found that there were no significant differences within the University size category. In fact, it was noted that in general the people who stated that their teachers often use dual cameras as a method of control during online exams were very few and amounted to 18%. It was seen, however, that dual camera use is more prevalent in science

faculties; in fact, the difference between the two clusters in the University path category is statistically significant. For science universities we have a percentage of 31%, while for humanities universities it is 18%.

Continuing with the analysis, it was considered relevant to analyze whether at the question "I believe that cheating during online exams is easier than in-person exams" there were significant differences in proportion within the category proctoring and within the category dual camera.

Regarding the proctoring category (whose clusters are people who frequently use proctoring tools - people who do not use proctoring tools) what emerged is that there is no significant difference between the two clusters (the two means are both around 3). Thus, this implies that indeed both those who habitually use proctoring tools and those who do not on average think that copying during online exams is easier than copying during in-person exams.

On the other hand, as for the dual camera category, the result that emerged is interesting because people in the Dual camera users cluster generated on average a response approximating 2 - Do not really agree. In contrast, people belonging to the NOT Dual camera users cluster generated an average response approximating 3 - Quite agree. Effectively then, we can say that the use of dual camera has a significant effect on students. Therefore, this method is certainly more effective than the use of proctoring tools. The fact that the dual camera is able to fully film the student makes cheating much more difficult.

Finally, what were found to be the easiest methods for students surveyed to cheat during online exams were listed. It was seen that almost all of the methods turn out to be quite avoidable if dual cameras were used more frequently as a tool for checking students.

Conclusions

This thesis work pointed out what were the highlights of distance learning from the students' perspective.

To do this, data were collected through a survey administered to 331 Italian students, and the responses were then analyzed through various statistical tests including Chi-squares test for homogeneity, t-test, and the comparison of two population proportions.

It was seen that certainly one of the aspects that most influences students' perceptions of distance learning are the context in which they live, which for simplicity in the thesis work was called the "External environment" and encompasses together the conditions of the computer used by the student, the Internet connection and the environment in which the student's workstation is located.

In addition, what could be noted is that alternative teaching is generally highly appreciated by students since it is an aid to maintaining contact with other students.

Finally, one of the most worrisome aspects found is that the tendency to cheat during online exams has increased greatly, and one way to remedy this could be to increase the use of dual cameras as a method of monitoring students.

As for future insights, it certainly might be interesting to conduct a parallel survey involving professors to better understand the main difficulties they encountered and what, on the other hand, they found useful and helpful in carrying out their profession.

In addition, it would also be interesting to investigate more about the external environment to understand better what factors affect the students’ overall experience with distance learning the most.