
Students' learning outcomes and satisfaction. An investigation of knowledge transfer during social distancing policies

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Abstract: During the COVID-19 pandemic, the researchers discovered that a billion students accessed digital channels, thus confirming the centrality of digital technologies in education. Considering that student satisfaction refers to a short-term attitude resulting from an evaluation of the educational experiences lived and that the perceived quality of an educational background is a consequence of student satisfaction, this paper investigates the role of e-learning practices in a knowledge transfer's environment, such as the university. Mainly, through an exploratory analysis, the paper gives some specific insights, investigating students' satisfaction in terms of interaction between students, technology, and original contents. The results show how digital technologies are transforming the education experience by shedding light on e-learning outcomes and students' satisfaction. The principal managerial implications of the paper focus on the begin to understand the need to acquire digital infrastructures in Universities, reducing the technological gaps, and considering the implementation of online learning solutions.

Keywords: knowledge transfer; students' satisfaction; digital environment; digital transformation; e-learning; digital technology; learning environment.

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1 Introduction

Digital transformation radically changes social and economic environment (Carayannis and Meissner, 2017; Chahal and Bakshi, 2014; Del Giudice et al., 2019; Howitt and Leonard, 2009). The adoption of digital technologies enabled new opportunities for higher education institutions (HEIs) and universities (Carayannis and Meissner, 2017), becoming an integral part of the education experience (Ceballos et al., 2017; Henderson et al., 2017). Digitalisation has been recognised as a great opportunity by the HEIs and universities (Henderson et al., 2017), especially in COVID-19 period. According to the Triple Helix model, defined as a synergic set of interactions between universities, industry, and government, (Etzkowitz, 2008; Leydesdorff, 2012), the universities assumes an essential role (Magni et al., 2020). The digital transformation also suggests shedding light on the role of technology concerning the students' experiences (Garcia, 2006). Notably, a fundamental aspect of the strategy adopted by the HEIs is about the development of digital technologies and interactive tools aimed to improve the processes of knowledge transfer, through an active students' involvement (Ceballos et al., 2017; Del Giudice et al., 2019; Magni et al., 2020; Vargas-Vera et al., 2013). Furthermore, the development of dynamic innovations within the university helps the heterogeneity of knowledge to activate specific paths on the creativity and innovation of entrepreneur students (Curado and Bontis, 2006; Garcia, 2006; Magni et al., 2020).

In the current COVID-19 scenario, some research discovered that about 1.6 billion students accessed digital channels for their education (Edmondson, 2020; Hodges et al., 2020), revealing once again the centrality of digital technologies. Considering these premises, the aim of this paper is to investigate the emerging relationships between the academic training of students and the use of digital technologies, in a knowledge-intensive environment such as the university. Through a survey administered to a sample of Italian university students during the pandemic from COVID-19, which imposed measures of social distancing and an obliged use of digital channels to access education, focused on the impact that digital tools on student satisfaction as an alternative educational channel.

According to the 'Biennial report on the state of the university system and research' (ANVUR, 2018), 90% of the students interviewed are not fully satisfied with the technological equipment made available by the university, complaining the lack of computers for students and teachers during lessons, the lack of access to online courses (81%) and streaming lessons (86.5%), as well as digital whiteboards in the classrooms (77%). To overcome the lack of digital skills, the university must reshape educational methods, immersing the educational process in the so-called Technological Revolution or Fourth Industrial Revolution (Ahmad et al., 2018). The digital transformation causes

disruptive changes from a social and economic point of view, encouraging the acceleration of scientific and technological knowledge (Carayannis and Meissner, 2017; Khaliq et al., 2018). Through the composition of digital learning and skills shared and transferred to students, education plays a significant role in the development of socio-economic and dynamic innovation and, at the same time, lays the foundations for building a knowledge society (Martini and Vespasiano, 2015; Pantano et al., 2018).

Analysing the context of the Italian university allows us to expand knowledge on specific aspects in a country with a robust technological gap compared to other European countries (ANVUR, 2018). The Italian university context is strongly distinguished from the rest of Europe: the percentage of the Italian population, in the age group 25–34, in possession of a university degree is still very low. Italy ranks penultimate in the ranking of EU-27 countries, with a percentage of 26.9%, against 39% of the EU-27 average, (ANVUR, 2018). The research aims to analyse the Italian context precisely to highlight and identify the impact and effects of COVID-19, at the level of online teaching, in contexts with substantial technological gaps.

The paper is structured as follow. In the next section, we present the conceptual foundations of digitalisation in the education environment and its potential role in students' satisfaction. Then, we describe the methodology that we implemented in the empirical study, describing the obtained results. Finally, we discuss those results, suggesting theoretical and practical implications, along with limitations and directions for future research.

2 Literature review

2.1 Digital transformations and soft skills in universities

Digital transformation is continually evolving, and it has an impact on society and organisational models, both in terms of simplification and replacement of specific processes (Ahmad et al., 2018; Khaliq et al., 2018; Nicotra et al., 2018). Technology alone is not enough to gain a competitive advantage, but digital skills must be developed to integrate technology into society and, therefore, also into the educational context (Altbach et al., 2019).

Emerging digital technologies reshaped the education systems (Carayannis and Meissner, 2017; De Pablos, 2004) and digitalisation imposed a profound transformation at all organisational levels, shedding light on new skills required (Vargas-Vera et al., 2013), to face traditional activities (Nicotra et al., 2018; Secundo et al., 2017). The speediness of these changes requires organisations and universities to have a digital mentality and an adequate adaptation capacity to interiorise the ongoing transformation processes (Secundo et al., 2017). HEIs and universities should become aware of this transition (De Beer et al., 2017; Magni et al., 2020), stimulating the formation e-skills – IT related- and soft skills, considered useful for to manage and ride the digital transition (Nicotra et al., 2018).

In today's scenario of disruptive changes, the education system is called to respond to an unprecedented challenge that has turned out to be even more urgent in the period of COVID-19 emergency. Several studies believe that a more courageous organisational rethinking of the services offered in universities is necessary, through the exploitation of new and specific transversal skills that allow human capital to operate efficiently and

synergistically in a highly dynamic context (Ahmad et al., 2018; Campanella et al., 2013; Elsharnouby, 2015; Henderson et al., 2017; Magni et al., 2020). In this perspective, many scholars (Leris et al., 2014; Sousa and Rocha, 2019) have found a double interpretation on the role of new transversal skills: on the one hand, there is an approach more optimistic, in which transversal skills help firms and universities to manage technological transformations synergistically; on the other hand, a more pessimistic approach, which predicts that the digital revolution has a disruptive impact on the current scenario. The degree of instability of the environment and the degree of exploitation of resources by the actors determined the concerns of the economic and social impact of new technologies on transversal skills (Khalique et al., 2018). Therefore, a profound rethinking of the methods of developing digital skills, teaching tools and practices is necessary (Del Giudice et al., 2019).

The social distancing measures imposed for the containment of COVID-19 disease, has shown a sudden storm in the provision of education, activated by digital channels (McKinsey, 2020; Hodges et al., 2020). Mainly, the distance learning (or e-learning) is a formalised teaching and learning system specifically designed to be carried out remotely by using electronic communication tools (Edmondson, 2020). Isolation increased the use of digital channels and stimulated the students' passage from an offline education environment, to an online fruition (McKinsey, 2020). More than other people, students exploited digital channels, either for educations and leisure scope; they benefitted of e-learning services, additionally spending their time online in platforms such as Netflix, Spotify, or pouring their social interactions with peers, friends, and relatives on video-call platforms such as Skype (McKinsey, 2020).

Formally we suggest that:

- H1a During the COVID-19 pandemic, the average number of hours spent online (for recreational or educational reasons) by Italian students is significantly higher compared to the pre-pandemic period.
- H1b During the COVID-19 pandemic, the average difficulty in attending a university course for Italian students is higher compared to the pre-pandemic period.
- H1c During the COVID-19 pandemic, the average satisfaction in attending a university course for Italian students is lower compared to the pre-pandemic period.

2.2 *The students' satisfaction in University 4.0*

Student satisfaction refers to a short-term attitude resulting from an evaluation of the educational experiences lived (Hartman and Schmidt, 1995). De Beer et al. (2017) concluded that the perceived quality of an educational background is a consequence of student satisfaction. Grossman (1999) found that satisfaction is significantly influenced by the student's trust in the university. Trust is achieved by treating students consistently and fairly, meeting their expectations and managing their needs carefully. Student life is a network of interconnected experiences that overlap is affecting student satisfaction. Student satisfaction is, therefore, the result of the sum of the student's academic, social, physical, and digital experiences (Campanella et al., 2013; Leris et al., 2014).

In the current scenario, the university's services are shifting from a physical and face-to-face assistance to a fluid and online use. Magni et al. (2020), already express the concept of university 4.0, that is an academic environment inclined to welcome new

technologies and to be contaminated by digital transformations, to create a place of identity and that favors, as much as possible, the satisfaction of students' needs. A pull logic of insertion of digital technologies driven by students' latent needs do not justified the revolution in the provision of university services, as did a push logic, or through passive forms of technological absorption by society and the educational context (Elsharnouby, 2015). Online teaching has revolutionised the students' needs and the quality perception of education (Magni et al., 2020).

The COVID-19 crisis also affected students' perception of the provided education and their satisfaction (Hodges et al., 2020). The social distancing policies forced the universities to face a mandatory technological revolution, driven by new contingent needs (Edmondson, 2020). Magni et al. (2020), proposed the framework of University 4.0, as an academic environment inclined to welcome new technologies and to be contaminated by digital transformations, increasing the students' satisfaction. In this scenario, the recent fruition of the courses offered by universities has been based on distance teaching-learning (Hodges et al., 2020; Secundo et al., 2017) according to a sort of University 4.0. Thus, the distance teaching shows new challenges deriving from the interaction between students and technology, between students themselves, and contents (De Beer et al., 2017).

Additionally, several studies (Magni et al., 2020; Munari et al., 2016; Secundo et al., 2017) have shown that there is a positive impact of technology only when the educational context can internalise it. Otherwise, the implementations of technologies in non-ready environments would be involved and ineffective (Munari et al., 2016; Secundo et al., 2017), characterised by a robust technological gap, such as the Italian one. Technological innovation has a non-homogeneous impact on society and on the entire university ecosystem (Carayannis and Meissner, 2017). The effect is positive when the educational context has the tools to be able to exploit innovation. On the contrary, the insertion of 'technological novelties' in non-ready environments and with a robust technological gap, is more complex and less effective (Magni et al., 2020; Munari et al., 2016). Emergency online teaching has highlighted these issues, and the quality of the educational experience may have been affected, also affecting the degree of student satisfaction.

According to the 'Biennial report on the state of the university system and research' (ANVUR, 2018), from a technological perspective, there is a substantial technological gap within the Italian university structures. Students are not fully satisfied with the specialised equipment available in their university. These results have inspired our research to investigate the perception of students of Italian universities in an extreme case, particularly concerning educational activities that can only be fruited via online channels (Munari et al., 2016), as in the current COVID-19 period.

Formally then we will have that:

- H2a During the COVID-19 pandemic, the student-technology interaction positively influences Italian students' satisfaction in the use of online teaching.
- H2b During the COVID-19 pandemic, the student-content interaction positively influences Italian students' satisfaction in the use of online teaching.
- H2c During the COVID-19 pandemic, the student-student interaction positively influences Italian students' satisfaction in the use of online teaching.

3 Methodology

3.1 Sampling description

To test our hypotheses, a structured questionnaire was administered to a sample of students at RomaTre University between April and May 2020, during the COVID-19 pandemic, via Google Forms platform 67 Italian students. Approximately 35% of the students were male, compared to 65% of female. Slightly more than 32% were in the 19–20 age group, while 34% were in the 21–22 age group. The age group 23–24 is also consistent (around 21%), while over 25 we find 12% of respondents in total. Finally, about 67% was attending an undergraduate program, against 33% of them who was attending a master's degree program.

Regarding the socio-demographic data, the level of technological equipment of the students was analysed. Particularly they shown a comprehensive possession of digital technologies and tools such as personal computer (76.1%), ADSL, fiber or Wi-Fi connections (70.1%), and smartphones (86.6%). Finally, concerning the latest-generation technologies such as Android box and Alexa, only 7.5% of respondents have of them.

3.2 Questionnaire design

The questionnaire consisted of four main parts. The first section was devoted to a descriptive overview of the current period of COVID-19 and to indagate the purpose of the research.

The second part of the questionnaire was developed to collect the socio-demographic data of the respondents (age, gender, provenance, level of education). Furthermore, this second part ends with the collection of information on the technological equipment of the respondent. The third part of the questionnaire was dedicated to the comparison between students' online habits before and during the COVID-19 period. Finally, the fourth part of the questionnaire is dedicated to the analysis of peculiar interactions developed in the current period of COVID-19. The purpose of this last section is to validate items for measuring student satisfaction for attending online courses provided by the University of Roma Tre. To compose the first list of items, an ad hoc qualitative analysis was conducted using a focus group. The focus group was organised to brainstorm on useful elements regarding student satisfaction in the period of COVID-19 and the definition of the potential variables that influence the final result. The focus group had four participants, including junior researchers in the fields of marketing and management. The last step was to involve a group of experts, i.e., academics and professionals in the areas of Higher Education, management and consumer behavior, to examine the complete list of items. In the end, 20 items relating to the use of online courses and student satisfaction were selected. The respondents were asked to indicate, on a Likert scale from 1 (disagree) to 7 (fully agree), their opinion regarding the 20 items of the questionnaire.

3.3 Data analysis techniques

A three-step procedure was used to analyse the chapter data. Firstly, a single sampling test was used to measure any significant differences in students' behavior and use of the network, before and during the COVID-19 period. To answer the first research question (*H1a*, *H1b*, and *H1c*), the single-sample *t-test* technique was used. In the second analysis

step, the PCA (Principal Components Analysis) technique was used to determine the scale and dimensions underlying the student satisfaction component investigated in the questionnaire. Finally, we conduct a multiple regression analysis through the statistical packages IBM SPSS 25.0.

4 Results

4.1 Use of network and e-learning before and during COVID-19

To investigate any differences in the use of the structure and to verify the various online presence, both for leisure reasons (including viewing movies on Netflix or Amazon Prime), and for educational and academic purposes (through the use of digital platforms such as Zoom or Teams) a *t-test* analysis was conducted. The descriptive data has shown a substantial increase in the use of the Internet and the time spent online, both for leisure and educational reasons, confirming *H1a*. Notably, the analysis focused on the significant difference in the time spent in using digital technologies, before and during the pandemic period (Table 1).

Table 1 Analysis of differences in online usage times before and during COVID-19

	<i>Before COVID-19</i>	<i>During COVID-19</i>	<i>Difference of means</i>	<i>t-test</i>
Time spent online	3.15	4.37	1.22	8.07***
Time spent online for leisure reasons	2.61	3.61	1.00	5.75***
Time spent online for educational reasons	2.03	3.31	1.28	8.97***

Note: Coefficients marked with ***, ** and * suggest that they are significant at the 1%, 5%, and 10% levels, respectively.

As in Table 1, we confirm *H1a*: the average of time spent online by students, both for leisure and educational purpose, is significantly higher than the pre-pandemic. Indeed, all three *t-tests* was significant ($t = 8.07$; $t = 5.75$; $t = 8.97$ for $p\text{-value} < .000$). To analyse and test the research hypothesis *H1b* and *H1c*, we launched two other *t-tests* for single samples. Thus, we investigated the differences between

- 1 the average difficulty in attending an online course during the pandemic and pre-pandemic period
- 2 the average satisfaction in students' participation in an online course (Table 2a, Table 2b).

Table 2a Analysis of the differences in difficulty in attending online courses before and during COVID-19

	<i>Before COVID-19</i>	<i>During COVID-19</i>	<i>Difference of means</i>	<i>t-test</i>
I have no difficulty in attending online courses	5.39	3.48	-1.91	-6.93***

Note: Coefficients marked with ***, ** and * suggest that they are significant at the 1%, 5%, and 10% levels, respectively.

Table 2b Analysis of differences in satisfaction in attending online courses before and during COVID-19

	<i>Before COVID-19</i>	<i>During COVID-19</i>	<i>Difference of means</i>	<i>t-test</i>
I attend with satisfaction online courses	5.42	3.09	-2.33	-8.33***

Note: Coefficients marked with ***, ** and * suggest that they are significant at the 1%, 5%, and 10% levels, respectively.

As in Tables 2a and 2b, we confirm the research hypotheses *H1b* and *H1c*. The *t-test* analysis show that the difference is negative and significant (respectively $t = -6.93$ and $p\text{-value} < .000$; $t = -8.33$ and $p\text{-value} < .000$). In this pandemic period the average difficulty in attending university online courses is significantly higher than in the pre-COVID-19 period and, at the same time, the average satisfaction in attending an online course is also statistically lower than in the pre-pandemic period.

4.2 Identification of the dimensions underlying student satisfaction in online courses

Considering the 67 observations collected, a PCA was conducted (used a Varimax rotation) to answer the second research question (*H2a*; *H2b*; *H2c*). Table 3 illustrates the factor structure of 20 items.

The KMO value is 0.831 and Bartlett's test is significant at the level of $p\text{-value} < 0.000$ and $\chi^2(6)=153$. The dimensions have been renamed based on the typical characteristics of the items included in each single factor. The interaction between student and technology (IST) is defined as the ability and the level of comfort that the student has with non-human interaction, i.e., using technology in an online environment (De Beer et al., 2017). Student-content interaction (ISC) is defined as the non-human interaction that the student has with matter and digital content (Hodges et al., 2020). Student-student interaction (ISS) is defined as the human interaction consisting of two-way communication between a student and other students in the class (Magni et al., 2020). Overall satisfaction is defined when the student's primary needs have been met (Henderson et al., 2017).

Once we find the dimensions of the student satisfaction scale, we proceed to investigate the research question (*H2a*; *H2b*; *H2c*). Through the multiple regression analysis, the three independent factors (IST; ISC; ISS) was tested as determinants of student satisfaction in the use of online course in the current COVID-19 period. Table 4 shows the results of the regression model for the research hypothesis; R-Square's model is 66.7%.

As in Table 4, the interaction between student and content (ISC), and the interaction between student and technology (IST) was the fundamental ones in predicting the students' satisfaction of online courses. IST show Beta coefficient of 0.184 (positive and significant at $p\text{-value}=0.028$); ISC show Beta coefficient is 0.790 (also positive and significant at $p\text{-value}=0.000$). The factor that is not significant in predicting student satisfaction in the online course fruition is the ISS. The ISS assumes a negative coefficient (beta = -0.092) and no-significant $p\text{-value}$. Summarising, only IST and ISC, significantly contributed to the prediction model of students' satisfaction in using online courses (*H2a* and *H2b*), differently than ISS (*H2c*).

Table 3 Factor analysis

<i>Variables</i>		<i>Factors</i>	<i>Cronbach's alpha</i>
Student-technology interaction (STI)	I find very easy to work with the computer	0.899	0.888
	I can face most of the difficulties I encounter when using the computer	0.851	
	Working with the computer makes me much more productive	0.817	
	I am very confident in my ability to use technology (laptop, smartphone, pc)	0.788	
	The use of computers makes learning more interesting	0.784	
	I consider myself a skilled technological user	0.680	
Student-content interaction (SCI)	The learning activities in e-learning courses required critical thinking which facilitated my learning activities	0.938	0.954
	The online platforms connected to the e-learning courses facilitated my learning activities	0.923	
	The tasks and / or projects during this e-learning period facilitated my learning activities	0.909	
	The learning activities in the e-learning courses required the application of problem-solving skills which facilitated my learning	0.904	
	The materials of the e-learning courses used in the class facilitated my learning activities	0.894	
	I feel that this online class experience has helped me improve my communication skills	0.849	
Student-student interaction (ISS)	Online courses have encouraged students to discuss other students' ideas and concepts covered with	0.939	0.901
	Online courses have created a sense of community among students	0.913	
	In online classes I was able to ask a fellow student for clarification when needed	0.887	
	In online classes, the online discussion forum offered the opportunity to solve problems with other students	0.789	
Student satisfaction (SS)	I learned a lot in these online courses compared to the courses in presence at the university	0.901	0.886
	I was very satisfied with the online and e-learning courses offered by the university	0.891	
	I believe that online courses are as effective as courses in presence at the university	0.871	
	I am willing to take another online course	0.821	

Table 4 Multiple regression analysis with SS dependent variables

<i>Variables</i>	<i>Beta</i>	<i>t</i>	<i>Sign</i>	<i>VIF</i>
IST	0.184	2.247**	0.028	1.273
ISC	0.790	6.912***	0.000	2.470
ISS	-0.092	-0.809	0.422	2.471

Note: Coefficients marked with ***, ** and * suggest that they are significant at the 1%, 5%, and 10% levels, respectively.

5 General discussion and conclusion

This study highlighted how digital technologies are transforming the education experience by shedding light on e-learning outcomes and students' satisfaction. Before the pandemic from COVID-19 universities, fewer approached online lessons and digital channels (De Beer et al., 2017). Despite the increased time spent online, digital for education and leisure purpose show significant differences (Edmondson, 2020). The impact of digital tools in the current unexpected scenario due to the pandemic, revealed strong adaptability by universities, outlining procedures for the resumption of activities following the period of social distancing. We confirm that education managers should available counterbalance their technological gap (Chahal and Bakshi, 2014; Ceballos et al., 2017; Curado and Bontis, 2006), by leveraging on digital tools considering creating collaborative and interactive environment; those more advanced should enhance the digital usability of implemented online courses as well (Henderson et al., 2017).

The potential renewal of teaching methods and university practices must take into account the attitudes and behaviors of new generations of students towards technologies. The recognition of the experiences of applying digital tools in the educational context demonstrates the growing weight of participatory culture and informal learning (Altbach et al., 2019). The research confirms not only the potential but also the criticalities of an online transition: unable to provide face-to-face teaching, universities have tried to provide educational continuity through emergency online remote teaching. At this time, universities are focusing on ensuring academic continuity for students and, in many cases, this has meant relying on ready-made online study courses or on streaming classes using distance learning platforms. These measures, although effective, do not always have a single and homogeneous effect on the level of learning and satisfaction of students (Henderson et al., 2017; Leris et al., 2014).

Contrary to online teaching experiences, emergency online remote teaching is a temporary transition from traditional mode (face-to-face or hybrid courses) to an alternative modality due to crisis circumstances. In this case, the main objective is not to recreate a reliable educational system but rather to provide temporary access to education that can quickly and reliably allow to overcome the emergency scenario.

Students will have a high level of satisfaction deriving directly from their educational experience (Leris et al., 2014). In fact, before the COVID-19 emergency, in the Italian university world, few had participated in an online lesson. The COVID-19 emergency has created a technology shock, which has forced universities to transform traditional teaching into online teaching. The emergency causes an immediate response from the organisation aimed at finding a solution to a contingency that, in the future, makes the organisation able to take advantage of new opportunities and challenges. These challenges can occur on several levels: balance or removing the technological gap still present in Italian universities (Munari et al., 2016); removing psychological barriers to change in knowledge-intensive environments (Leris et al., 2014); implement digital strategies for the long term (Magni et al., 2020) and train the leaders of the future (Ahmad et al., 2018).

The evolution of the university ecosystem has an 'unstable equilibrium' given by the succession of long periods of relatively slow change, interspersed with eclectic and occasional moments of rapid adaptation (Edmondson, 2020). In the current scenario, the university is working hard to revitalise teaching and learning using technology, and collaboration by leveraging on digitalisation (Hodges et al., 2020). Universities need to

begin to understand the importance of acquiring digital infrastructures and the need to reduce their technological gaps, the vital interaction with the business environment, following the Triple Helix model (Etzkowitz, 2008; Leydesdorff, 2012), and the development of knowledge transfer.

The current emergency is a critical moment for the development of the entire system, which is working hard to restore teaching and learning using technology, innovation, and collaboration. Many questions will need to be answered, including for example: which courses will need to be reinvented online and what content can be transferred directly online without a significant loss of learning? Will it be possible to develop more complex virtualisation, gamification or augmented reality projects? Precisely, this constant digital advancement and openness to change in universities open the way to new potential theoretical and practical frameworks (Khalique et al., 2018).

Our work has some limitations. Firstly, the analysis is focused on a single Italian university and despite the selected sample shows statistically significant insights, it is not particularly plentiful. Furthermore, the analysis considers only some potential factors in determining student satisfaction and learning outcome. Future research could propose new items, thus widening the set of factors that condition student satisfaction in the use of online courses, additionally extending the investigations toward the teacher, professional, including the external environment.

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