Face-to-face and online learning: the role of technology in students' metacognition

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Abstract

The consequences of the COVID-19 pandemic have upset the structure of many organizations until reaching school, which has had to organize quickly for assuring online teaching. Traditional school, through its actors, should generate in the students the development of awareness towards their own way of learning, study flexibility, skills for self-evaluation and factors belonging to metacognitive strategies. The main aim of our research was to verify whether this general goal could be reached by both face-to-face and online learning. The Metacognitive Questionnaire on Study Method (QMS) was completed online by 324 students (125 males and 199 females) aged from 14 to 19, attending their classes on the "Google Classroom" platform. Our results suggest that both the conditions show advantages and drawbacks. *Attitude towards school and study* is better in face-to-face learning and *Metacognition and study* tends to be significantly more positive in face-to-face setting too. On the other hand, online learning enhances the use of subsidies and study flexibility as well as a minor anxiety state. Our results, albeit with their limitations, could offer many suggestions to the academic community committed to improving educational institutions.

Keywords [1] online and face-to-face school, metacognition, learning strategy

1. Introduction

The recent outburst of COVID-19 infection in Italy has determined the need for blended and online learning strategies, in order to contain the spread of contagion. Technology of e-learning has been implemented in the daily practice of teaching through the so-called DaD ("Didattica a Distanza", intended as "online learning" in English language) in public and private educational institutions. During the first lockdown in Italy, started from March 2020, thousands of children and adolescents have seen their schooling transferred on e-learning platforms and then, during the second wave of infection, the older adolescents especially have gone through the same experience again from October 2020.

Online learning protects from contagion, but it also opens up several unresolved questions. School should teach students how to manage workload, how to approach the subsidies and, more in general, it should allow to accomplish the meta-objective of "learning how to learn". Although global e-learning market surpassed USD 200 billions in 2019 and was expected to increase at over 8% CAGR (Compound Annual Growth Rate) between 2020 and 2026 [1], the capacity of online education to reach those goals needs to be fully understood. Indeed, online learning is not only a matter of technology, but also an interdisciplinary field encompassing behavioural, cognitive and constructive aspects [2]. Among those,

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online learning strategies, metacognition of e-learning and attitudes towards online school seem to be some of the most critical and interesting themes to explore.

According to Cornoldi and De Beni [3], the concept of "strategy" can be applied to all the situations that can be approached in different ways. Studying is one of those complex situations. A good study strategy should encompass the motivation for learning, the way work is organized and the flexibility of the management of the whole process. Study strategies have been variously explored in traditional face-to-face school, whereas their functioning online has been object of investigation only in the last years. For example, Ruey highlighted that a constructivist-based instructional design helped students change their perception of online learning, leading them to learn in a more cooperative, authentic and responsible way [4]. More recently, however, several studies have focused on the development of teaching strategies for online learning after the global COVID-19 pandemic. For example, Mahmood [5] talked about online teaching strategies that greatly enhance students' learning; these include the maintenance of a slow vocal language by teachers, their use of a more critical and creative thinking, the sharing of teaching materials with the class, and the implementation of a more flexible teaching. These strategies can certainly be integrated with the importance of making short subsidies, clear and interesting, using simple media and carrying out regular and continuous evaluations [6]. Another recent study, however, showed a positive correlation between self-efficacy and the use of self-regulated learning by students, highlighting how this construct is indispensable for the development of specific strategies, especially for online learning [7].

Metacognition, defined as "thinking about thinking" [8], plays a dual role as it contributes to the representation of the monitoring cognitive processes and it controls cognition through its representation [9]. It helps students concentrate, select information, choose strategies for studying and monitor all those steps. Although research analysing the use of metacognition in online learning is scarce, some studies have shown that using metacognitive tools integrated with online software has brought positive benefits to students, who have been reminded to use strategies such as taking notes and reflect on the teaching material [10] [11] [12]. It has been proven that teachers play a fundamental role in the development of metacognition, especially in the case of distance learning. They must support the development of this capacity in students, following specific measures such as recognizing social and cognitive aspects in students through discussions and responses, following a method of interrogation based on reflection and reasoning, providing constructive and immediate feedback, structuring students' cognitive tasks that lead them to self-monitor their learning, helping them become self-reflective professionals by promoting self-awareness [9]. Virtual laboratory activities also affect learning and metacognition of students. In particular, it seems that e-learning laboratory supports improve significantly the quality of learning and the metacognitive abilities of university students, despite being used within distance learning [13].

The representation of school is critical too. We might hypothesize that the perception of classmates, teachers and studying is related to the approach towards learning, as well as the emotional connotation of school and the style of attribution of performance outcome. More research in the specific context of online learning is required to clarify the influence of attitudes towards online school on students' motivation.

With this study, therefore, we intended to contribute to a better understanding of the metacognitive aspects of distance learning mediated by the technology of e-learning platforms (e.g., "Google Classroom"). In more detail, we explored the differences between online distance learning and traditional face-to-face learning referred to learning strategies, metacognition and attitude towards school in Italian High School students.

2. Aims

This research aimed at achieving the following objectives:

1. To explore the differences in learning strategies, metacognition and attitudes towards school between online learning and traditional face-to-face learning in Italian High School students;
2. To explore the influence of gender and typology of school on the differences mentioned above.

3. Materials and Methods

3.1.1. Participants

The participants who took part in this study were 324 adolescents, including 125 males (38,6%) and 199 females (61,4%), aged between 14 and 19 years (M = 16,70; SD = 1,059), who attended the third (126 adolescents, 38,9%), fourth (121 adolescents, 37,3%) and fifth (77 adolescents, 23,8%) class from different High Schools, corresponding to Education Level 3 in the International Standard Classification: 91 students (28,1%) from Humanities High School, 90 (27,8%) from Linguistic High School, 53 (16,4%) from Industrial Technical Institute, 48 (14,8%) from Computing Technical Institute, 26 (8%) from Classical High School and 16 (4,9%) from Scientific High School. These schools, located in Catania and its provincial seat, have been classified into two fields of study: the humanistic-literary one to which 207 (63,9%) pupils belong, and the technical-scientific one to which 117 (36,1%) pupils belong. All the participants involved in this research were attending their classes via online learning on the "Google Classroom" platform, because of the health emergency due to COVID-19.

3.1.2. Measures

The tool used in this study was the Metacognitive Questionnaire on Study Method (QMS) created by the MT Group [3], with the aim of assessing the study skills of students aged 10 to 15. This questionnaire has also been used and standardized with older adolescents attending High Schools and Universities.

The QMS is characterized by 163 items, which investigate 21 fundamental areas related to the study skills of students, attributable to 4 macro-areas:

1. *Learning strategies*, that is the different ways of each student of facing study situations. The fundamental areas that are part of it are: motivation to study, organization of personal work, use of subsidies, active material processing, study flexibility, active style during the lesson.
2. *Cognitive styles of information processing*, or the different ways in which information is analysed and interpreted by students. The fundamental areas composing it are systematic/intuitive cognitive style, global/analytical cognitive style, impulsive/reflexive cognitive style, verbal/visual cognitive style, autonomy and personal way of approaching the study.
3. *Metacognition and study*, i.e. the ability to think about the learning process itself. In this area concentration, selection of the main aspects, self-evaluation, test preparation strategies and metacognitive sensitivity are investigated.
4. *Attitude towards school and study*, which include the following fundamental areas: relationship with peers, relationship with teachers, school anxiety, attitude towards school, attributional style and commitment.

The items belonging to each fundamental area are evaluated using a 3-interval Likert scale ("a lot", "quite a lot", "a little"), depending on how much the statement corresponds to the individual perception of the student.

For this study, we decided to proceed with the administration of only the items belonging to the macro-areas *Learning strategies*, *Metacognition and study* and *Attitude towards school and study*, thus excluding *Cognitive processing styles of information*. The reason for this choice lies in the fact that the latter macro-area is not consistent with our research objectives, which involve differences in learning strategies, in metacognition and in the attitude towards school taking into account face-to-face and online learning. The same authors of the QMS suggest that the strength of the questionnaire is its flexibility, as selected use of the 4 macro-areas is admitted. As a consequence, our final tool was composed of 132 items.

The QMS was administered to students belonging to the third, fourth and fifth grades of High Schools only; in fact, it was deliberately decided to exclude pupils from the first and second grades for

various reasons. First of all, on the basis of ministerial decrees, first year students were allowed to attend face-to-face lessons during the second wave of infection; in this way, they have not fully experienced again the method of learning based on distance learning. Second year students, on the other hand, have most likely developed a study method strictly related to distance learning; because of this, it was difficult to verify any differences in learning strategies, metacognition and attitudes towards school before and after the influence of technology on teaching and learning. This does not happen, however, for third-, fourth- and fifth-year students, who had all the time to develop a more structured, personal and autonomous study method than their younger pupils.

In the administration phase, teachers played a fundamental role. In fact, they collaborated with the experts by presenting to the students the QMS in its online version. The questionnaire asked to rate each item twice: the first referred to face-to-face learning and the second to online learning.

4. Results

For statistical analysis, we used the Statistical Package for the Social Sciences (SPSS) version 25.0 (Armonk, NY: IBM Corp.). Paired and independent *t*-tests were used as well as cross tabulations with $\chi 2$ test for categorical variables.

Students' evaluation in the factors of the three macro-areas

In line with our aim, namely, to explore the students self-attributed study abilities both in face-to-face and online learning, we ran paired *t* tests to compare the sixteen factors belonging to the three macro-areas: *Learning strategy, Metacognition and study,* and *Attitude towards school and study*.

Table 1

Paired t test for the 6 factors of Learning Strategy macro-area

Factors	M	SD	t	p
FtFl 1	20,66	3,558	1,700	,090
ONLl 1	20,35	3,565		
FtFs 2	17,60	2,912	2,649	,008
ONLl 2	17,06	2,909		
FtFl 3	13,14	2,608	-4,376	,001
ONLl 3	13,62	2,643		
FtFl 4	17,52	2,820	2,622	,009
ONLl 4	17,12	2,792		
FtFl 5	14,81	2,103	-5,341	,001
ONLl 5	15,28	2,123		
FtFl 6	11,10	2,251	4,886	,001
ONLl 6	10,35	2,292		

Legend: **FtFl**: face-to-face learning; **ONLl:** online learning **1**: study motivation;
2: organization of personal work; **3**: use of subsidies; **4**: active analysis of the teaching materials; **5**: study flexibility; **6**: active style during the lesson.

Regarding our first macro-area, as it is shown in Table 1, organization of personal work, active analysis of the teaching materials, and active style during the lesson were significantly higher during school in presence. The use of subsidies like documentaries, pictures and so on, and study flexibility were significantly higher during the online school.

Table 2

Paired t test for the 5 factors of Metacognition macro-area

Factors	M	SD	t	p
FtFl 1	13,47	2,198	6,309	,001
ONLl 1	12,49	2,285		
FtFs 2	12,05	1,945	,555	,579
ONLl 2	12,00	1,860		
FtFl 3	15,58	2,586	,763	,446
ONLl 3	15,47	2,413		
FtFl 4	25,31	3,784	-,239	,811
ONLl 4	25,35	3,688		
FtFl 5	15,94	2,499	-,291	,711
ONLl 5	15,90	2,305		

Legend: **FtFl**: face-to-face learning; **ONLl:** online learning **1**: study motivation;**1**: concentration; **2**: selection of main aspects; **3**: self-evaluation; **4**: test preparation strategies;

5: metacognitive sensibility.

In this case, inside the Metacognition macro-area, only concentration was significantly higher during the school in presence. For the other factors, no significant differences were found.

Table 3

Paired t test for the 5 factors of Attitude towards School macro-area

Factors	M	SD	t	p
FtFl 1	21,89	3,740	5,999	,001
ONLl 1	20,96	3,573		
FtFs 2	21,06	3,238	,796	,426
ONLl 2	20,92	3,143		
FtFl 3	29,58	5,248	5,546	,001
ONLl 3	28,20	4,969		
FtFl 4	23,15	3,561	4,461	,001
ONLl 4	22,33	3,494		
FtFl 5	14,62	2,101	2,634	,009
ONLl 5	14,31	2,047		

Legend: **FtFl**: face-to-face learning; **ONLl:** online learning **1**: relationship with classmates;

2: relationship with teachers; **3**: anxiety; **4**: attitude towards school; **5**: attributional style and commitment.

Regarding this last macro-area, relationship with classmates, attitude towards school, and attributional style and commitment, were significantly higher during the school in presence. Particular attention deserves anxiety, significantly lower during the online school. Concerning the relationship with teachers, no significant difference was found.

Students' evaluation in the three macro-areas

Moreover, we decided to further compare the three macro-areas as a whole. We found a tendency to statistical significance for *Metacognition and study*: (face-to-face learning M = 82.34, SD = 9.79; online learning M = 81.21; SD = 8.85; t 1.84, p < 0.06); and a higher significance regarding *Attitude towards school and study* (face-to-face learning M = 110.30, SD = 8.50; online learning M = 106.73; SD = 8.60; t 8.15, p< 0.001).

In the subsequent analyses, we have taken into consideration the cases placed above and below the 10^{th} percentile threshold of the three QMS macro-areas standardization in the Italian population [3].

Table 4

Subjects below and over normative sample threshold (percentile 10^{th} = 83) in the macro-area Learning Strategy

	below	over	χ2	df	p
Face to face learning	34	290	0.73	1	0.39
Online learning	42	282			

Table 5

Subjects below and over normative sample threshold (percentile 10^{th} = 73) in the macro-area Metacognition

	below	over	χ2	df	p
Face to face learning	39	285	0.85	1	0.36
Online learning	48	276			

Table 6

Subjects below and over normative sample threshold (percentile 10^{th} = 99) in the macro-area Attitude towards School

	below	over	χ2	df	p
Face to face learning	26	298	6.18	1	0.01
Online learning	47	277			

The comparison is significant for the *Attitude towards school and study* macro-area only. Indeed, the number of students under the threshold has nearly doubled (Table 4). For the other two areas no significant difference was found (Table 5 and Table 6).

Gender differences in the three macro-areas

We found interesting to investigate any gender differences taking into account the three macro-areas as a whole during online learning and face-to-face learning.

Table 7

Independent t test in the three macro-areas according to gender variable

	Gender	N	Mean	Ds	t	p
face-to-face school						
Learning Strategy	male	125	92,93	13,281		
	female	199	96,02	8,907	-2,295	,023
Metacogni-tion	male	125	79,78	11,361		
	female	199	83,94	8,304	-3,794	,001
Attitude towards school	male	125	108,42	9,417		
	female	199	111,48	7,661	-3,052	,003
online school						
Learning Strategy	male	125	93,06	12,913		
	female	199	94,24	8,506	-,985	1,190
Metacogni-tion	male	125	80,34	10,527		
	female	199	81,75	7,593	-1,393	1,009
Attitude towards school	male	125	106,00	9,696		
	female	199	107,19	7,837	-1,208	,228

This result is very interesting. During the school in presence, females performed significantly better than males in all three macro-areas; with the arrival of online learning, these differences have been eliminated, making the scores of the two genres superimposable.

School types differences to the three macro-areas (H-L; T-S)

As last analysis, we observed the differences in school types – *humanistic-literary* (H/L) and *technical-scientific* (T/S). We took into account the three macro-areas during online learning and face-to-face learning.

Table 8

Independent t test in the three macro-areas according to types of school variables

	Type School	N	Mean	Ds	t	p
face-to-face learning						
Learning Strategy	H/L	207	96,03	9,450		
	T/S	117	92,69	12,826	-2,674	,015
Metacogni-tion	H /L	207	83,90	8,649		
	T/S	117	79,57	11,055	2,462	,001
Attitude towards school	H/L	207	111,00	7,803		
	T/S	117	109,06	9,519	3,902	,048

			online learning			
Learning Strategy	H/L	207	94,39	9,250		
	T/S	117	92,72	12,203	1,386	,200
Metacogni-tion	H/L	207	81,83	7,616		
	T/S	117	80,11	10,643	1,680	,127
Attitude towards school	H/L	207	106,95	8,246		
	T/S	117	106,34	9,235	,607	,557

In this last analysis, it can be noted that, with face-to-face learning, students attending schools belonging to the humanistic/literary area obtain significantly higher scores in all three macro-areas of the QMS; opposite, with the online school these differences disappear: no significant differences emerge in the three QMS macro-areas.

5. Discussion and Conclusion

COVID-19 pandemic has brought many upheavals in human habits, ranging from social relationships to school, where young students must have adapted to online learning in a quick time. Attending school should contribute to the students' awareness of their own way of learning through cognitive, affective and social processes. This is the main objective of school when the education of successful pupils is taken into account. Our research attempted to verify whether this general goal could be reached by both face-to-face and online learning.

According to our results referred to the *Learning strategy*, organization of personal work, active analysis of teaching materials and active style during lessons were better during the traditional face-to-face schooling. Instead, online technology has enhanced the use of subsidies and study flexibility, while study motivation seemed not to differ in the two conditions. Those data suggest that being physically in the classroom improves the ability of managing assignments, monitoring achievements, processing new information, asking questions to teachers and intervening during lessons. At the same time, attending school via technological platforms facilitates the consultation of videos, pictures and online databases, maybe because they are accessible more easily, and also enhances the use of different approaches to studying. These results are similar to the ones obtained by Martin & Valdivia [14], who report that online environments enhance student-centred learning and engagement in learning as well as active processing. From this point of view, online learning opens up new ways of experiencing schools, but at the same time reduces a direct and stimulating participation. Our results are consistent with the findings of other authors, who found out that face-to-face setting is preferred for communication purposes, whereas online setting is preferred when self-regulated work is taken into account [15].

Focusing on the *Metacognition and study* macro-area, face-to-face and online learning do not differ significantly in most of the composing factors. However, as we expected, concentration is higher during traditional in-presence lessons, maybe because teachers know better how to engage students thanks to the availability of contextual cues on their level of attention, as noted by other authors already [16].

Regarding the third macro-area, *Attitude towards school and study*, the results show that the relationship with peers, the attitude towards school and the attributional style and commitment seem to be significantly higher during face-to-face schooling. Probably this can be explained by the fact that students interact more in presence, having the possibility to create more structured and stable relationships with classmates. This also justifies a better attitude towards school, seen as an institution which is not only meant to support learning but also to create meaningful bonds. Furthermore,

attributional style and commitment are likely to be higher in the face-to-face school as the feedback students receive from teachers stimulates them to engage more in their learning goals, whereas online learning reduces strongly this kind of interaction. A particularly interesting datum seems to be given by the anxiety factor, which is reduced during online school. This could be due to the fact that a structured situation such as the school environment can cause more tension than the security that one's home is able to transmit. This result enriches what is present already in the literature, where a general influence of anxiety in online students is well described, particularly when related to student's satisfaction [17]. Bolliger and Halupa [18] stated that students' feelings of anxiety are negatively associated with their satisfaction with online learning. Lu, Hu, Gao, and Kinshuk [19] reported a negative relationship between test anxiety and computerized adaptive testing performance, while Gupta [20] found that team-based e-learning can reduce perceived anxiety and thus, improve training outcomes. These results should be better defined with the help of further studies.

Regarding the relationship with teachers, we expected that it would be better in presence too, but actually no significant difference was found.

As an overview, we found out that *Attitude towards school and study* is better in face-to-face learning, whereas *Metacognition and study* tends to be significantly more positive in face-to-face setting too. Females performed better in all the three macro-areas during in-presence teaching, but online condition levelled any kind of gender discrepancy. Students attending humanistic/literary schools registered higher scores in all three the macro-areas only in traditional in-presence condition.

Whether online courses are equal to face-to-face ones is still on debate, however our study contributes to clarify this research theme being also, at the best of our knowledge, among the first studies on metacognition in online vs face-to-face learning during COVID-19 pandemic in Italy. Our results suggest that both the conditions present drawbacks and advantages, also confirmed by recent literature. In the last years, studies have been conducted on the effect of education enhanced with e-learning: Yu, She, and Lee [21], in a study that explored learning problem-solving through web-based education, found that low-achieving students could benefit from web-instructional methods, stating also that online learning environment improves the students' ability to identify essential information, making them more capable of developing potential solutions to solve ill-structured problems. To sum up, it seems that blended courses could assure the best results from a cognitive perspective.

It should be noted that this research suffers from some limitations too. For example, students completed the questionnaire during the online learning period, so the face-to-face scores derived from the retrieval of past perceptions and experiences; moreover, the distribution of students in humanistic-literary and technical-scientific schools is not balanced. In any case, results seem coherent both between themselves and with the literature.

Future research should explore better the differences between face-to-face and online learning in order to give precious suggestions to social and political community, so that the upheaval brought by pandemic can be transformed into an occasion to improve services and personal development.

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