

Mathematics Anxiety at different schooling conditions during COVID-19

Subjects: **Psychology**

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The COVID-19 pandemic has caused unprecedented changes in the educational system, requiring students to continually switch between distance and in-person learning conditions. During the second wave of COVID-19, 405 students, recruited from twelve middle schools of Catania province (Italy), completed an online version of the MeMa questionnaire, answering each item twice and imagining themselves to be, respectively, in distance and in-person learning conditions.

mathematics anxiety

distance learning

in-person learning

metacognition

COVID-19 pandemic

1. Introduction

For two years now, the COVID-19 infection has changed the way students experience school. Indeed, as is generally known, their habits have been upset by shifting many times from in-person learning (PL) to distance learning (DL) conditions to manage and reduce the risk of contagion. Although it is clear that historical events related to the COVID-19 pandemic have determined a major development of the technological sector, the cognitive, emotional, and social implications of distance, blended, and in-person learning conditions still need to be fully explored.

Sabirova et al. ^[1], for instance, wondered how those changes influenced pupils' academic stress and school wellbeing, defined, respectively, as the whole spectrum of negative physical and emotional states associated with the educational process and as a multidimensional construct comprising emotional and cognitive components connected to the scholastic environment ^[2]. This important question needs to be framed within a general worsening of pupils' mental health: according to many authors, during the COVID-19 pandemic more than one-fifth of junior high and high school students experienced negative psychological effects, such as severe levels of anxiety, depression, and stress ^{[3][4][5]}.

1.1. Students' Mathematics Anxiety

Mathematical skills are an essential ability for life, and they allow better outcomes in studies and job careers ^[6]. However, when compared to other subjects, one of the most frequently reported emotions linked to mathematics is anxiety, which increases with age and hinders math skills, causing avoidance and low mastery of mathematical

abilities [7]. Mathematics Anxiety (MA) is defined as the apprehension that one has about the capacity to do mathematics or ‘an illogical feeling of panic, embarrassment, flurry, avoidance, failing and fear, which are physically visible, and which prevent solution, learning and success about mathematics’ [8] (p. 312). It has been documented that MA produces its effects on physiological, cognitive, and emotional levels. Higher-math-anxious students reported increased heart rates [9], clammy hands, and when they face an upcoming mathematical task, they show neural activations similar to those found when individuals experience physical pain [10]. MA impairs the proper functioning of working memory, which is crucial as it is involved in more complex calculations such as multistep mathematical problems [11][12]. Students with MA describe feelings of nervousness, apprehension, and worry [13].

There is a negative relationship between MA and math performance [14][15]. Moreover, the literature shows higher levels of mathematics anxiety in females than in males [16][17] and in higher levels of education [18][19][20]. Moreover, metacognition seems to moderate math anxiety and predicts that performance will decrease as anxiety increases, except at high metacognition levels; furthermore, metacognition predicts confidence in accuracy: people with higher metacognition are more confident in their ability to answer problems correctly [21].



2. The present study

The present study intended to explore the differences in anxiety, mental states, and metacognitive awareness towards mathematics in both distance and in-person learning conditions among middle school students in Italy. The objective was threefold: (1) to understand whether students experience different levels of MA (distinguished by learning, evaluation, and general anxiety), mental states, and metacognitive awareness in distance vs. in-person learning conditions; (2) to verify the existence of differences between those who prefer the DL or PL of mathematics in terms of MA, mental states, metacognitive awareness, math marks, and favorite subject; and (3) to evaluate gender differences for all the variables considered in this study. The final goal, in conclusion, was to understand whether MA is related to learning conditions and whether other variables should be taken into account.

2.1. Participants

A total of $N = 405$ Italian students, 222 females and 183 males, aged between 11 and 14 years ($M = 12.56$; $SD = 0.64$) took part in the study.

2.2. Procedure

After the selection of the psychometric tool to administer, the questions were transferred to the Google Form platform and sent to many school principals. The administration took place during the COVID-19 pandemic, and

the pupils had already experienced at least 3/4 months of distance learning, divided into different times, depending on the trend of the infections and the closure of schools.

3. Findings

Most of the participants prefer in-person learning (71.6%) rather than distance learning (28.4%). This pattern becomes more evident when the students choose between the PL and DL of mathematics. In fact, a higher percentage of participants (85.4%) prefer in-person math classes rather than distance math classes (14.6%).

The students reveal a higher in-person math learning and evaluation anxiety, which is a major tension induced, respectively, by the teacher's explanations and by having to perform difficult tasks; they also show a higher generalized school anxiety in PL; that is, anxiety is extended to all other disciplines, not just math. Moreover, they refer to have a higher metacognitive awareness in mathematics, namely the beliefs that students have about mathematics skills, discipline, and learning, during DL. There are no significant differences regarding mental states.

Females experience higher levels of math evaluation anxiety both in person and online. Gender also affects generalized school anxiety with females reporting higher scores both in person and online.

Students who prefer to learn math in person obtained better scores on mental states, metacognitive awareness, and math learning anxiety, both when mathematics is learnt in person and when it is learnt by distance learning.

The participants who prefer the PL of math have better grades in math than the group that prefers DL. Furthermore, Pearson correlations indicate a negative correlation between math marks and the three MeMa anxiety subscales, both in PL and DL. Moreover, there is a positive correlation between math marks and mental states and metacognitive awareness both in DL and PL.

Finally, students who prefer scientific subjects present significantly lower levels of anxiety in all its three dimensions, both in the DL and the PL of math.

4. Conclusion

Although the students prefer to attend school as well as learn mathematics in PL, they experience lower levels of anxiety in math in DL rather than in PL. However, the preference for mathematics, which describes those who like it, plays an important role. On the one hand, if students perceive themselves to be good and well-evaluated, the way in which mathematics is taught does not matter, the anxiety will be lower because at the root there is the fact of loving mathematics. On the other hand, it is also true that lower levels of anxiety could facilitate the development of a better mathematics self-esteem and a preference for the subject. Further studies could investigate the causal direction of this relationship.

The recent development of learning technologies, boosted by public health concerns, should not be the only target for interventions focused on the emotional connotations of mathematics, whose reputation is one of being an anxiogenic subject. MA needs, rather, to be addressed by interventions focused on the attitudes of students and on their beliefs, metacognition, and motivation.

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