Errors: Springboard for learning or tool for evaluation? Ambivalence in teachers' error-related beliefs and practices

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Abstract

Teachers' beliefs about students' errors are influenced by structural factors and by other beliefs towards education and students that teachers may hold. The literature on this topic has provided some evidence and some mixed results. Furthermore, some structural aspects related to errors have not been considered in framing teachers' beliefs about errors, such as the use of grades as a classroom assessment practice, which is strongly related to errors in testing situations. Based on these premises, this study aimed to explore teachers' beliefs about errors and the practices teachers report using to deal with students' errors in the classroom and teachers' beliefs about the interdependence between grades and errors. Italian teachers ($N=33$) from primary, middle, and secondary schools had been interviewed and the qualitative data were analysed through reflexive thematic analysis. The results showed that, according to teachers, errors acquire different meanings in the learning process, which are related to the roles they play in fostering or not learning. Furthermore, in describing these roles teachers reported to use specific practices to deal with students' errors. Finally, teachers acknowledged that classroom assessment based on grades has a negative interdependency with errors that makes it difficult to present errors as a fruitful part of learning both in learning and testing situations. Our results reveal the ambivalence of teachers' beliefs about errors and shed light on the challenges the grading evaluation system poses to teachers.

Keywords Teachers' beliefs · Teachers' practices · Errors · Grading · Interview

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1 Introduction

Errors are an integral part of learning, and they have an essential role in boosting achievement (e.g., Metcalfe, 2017). Despite this, making errors at school may lead to negative consequences. For instance, after an error, students might be mocked by classmates, scolded by the teacher, or receive a bad grade. As for the first two possible negative effects, several studies have already shown that teachers play a pivotal role in creating an error-friendly educational environment by dealing positively with students' errors (Soncini et al., 2021; Tulis, 2013) and promoting an error-centred learning approach while teaching (Heemsoth & Heinze, 2014; Lee et al., 2020). Educational settings where errors are allowed and even encouraged (namely, where a positive error climate is established, Steuer et al., 2013) are effective in supporting students' knowledge revision, decreasing students' fear of making errors and promoting adaptive reactions towards errors (e.g., Heinze & Reiss, 2007; Kapur, 2008; Rach et al., 2013; Steuer et al., 2022). Surprisingly, less attention has been given to teachers' beliefs on students' errors, although some scholars argued that teachers' beliefs may drive teachers in giving sense to their teaching practices (e.g., Buehl & Beck, 2015; Skott, 2015). In line with that, the first aim of this study was to explore teachers' beliefs about errors and the practices teachers report to use to deal with students' errors during learning situations.

Another negative consequence of making errors is that students may incur negative evaluations, receiving a bad grade in testing situations. In this study we particularly focused on grades, a simple value-laden symbol (e.g., a letter or a number) used to assess academic performance, because they are negatively related to errors: the higher the number of mistakes in a test, the lower the grade. A few studies already focused on teachers' beliefs about classroom assessment (Brown, 2004; Pastore et al., 2019) and about errors during learning activities (e.g., Bray, 2011). However, to the best of our knowledge, no study so far has explored teachers' beliefs about the relationship between grades and students' errors. Therefore, the second aim of this study was to fill this gap in the literature, by shedding light on teachers' beliefs about the error-grading relationship. To address these research questions, we carried out an exploratory qualitative study based on the analysis of thirty-three interviews carried out with Italian primary, middle and secondary school teachers.

1.1 Teachers' beliefs and practices related to students' errors

As highlighted by Five and Buehl (2011), there is a lack of consensus in the literature on the definition of teachers' beliefs. In this study, we framed teachers' beliefs following Skott's (2015) suggestion to consider the core aspects of different definitions scholars have provided so far. Accordingly, in this paper teachers' beliefs are defined as individual mental constructs considered true by the person, that include a cognitive and an affective part, and that are stable and difficult to change (Skott, 2015).

The lack of a univocal definition of teachers' beliefs mirrors the lack of agreement in the literature about their relationship with teachers' practices. Evidence shows that beliefs influence practices, but also that practices influence beliefs (Buehl & Beck, 2015) and that teachers' beliefs and practices reciprocally influence one another (e.g.,

Basturkmen, 2012; Richardson, 1996; Thompson, 1992). In line with Skott (2015), beliefs are factors that can influence how teachers interpret and reflect on their teaching practices.

Considering research on teachers' beliefs about errors, most studies focused on two main areas: understanding the relationship between teachers' error-related beliefs and practices and the cultural and structural aspects that influence these beliefs and practices.

On the one hand, the first set of studies provided mixed results on the belief-practice link. Empson and Junk (2004) pointed out that teachers who believed that errors are an important learning opportunity did not report adopting error-handling practices consistent with this belief. Conversely, in a case study with four participants, Bray (2011) showed that different teachers' beliefs influenced how teachers structured the lesson. Indeed, only teachers who believed that errors provide learning opportunities focused the classroom discussion on students' errors. Another study (Pan et al., 2020) explored undergraduates' and instructors' error beliefs and their practices in generating errors during the lesson (a useful practice to increase the possibility of using errors fruitfully for learning). The authors found that both instructors and students believed that errors are useful for learning, but they tended to avoid errors and the deliberate generation of them. According to the authors, errors are considered undesirable outcomes of the learning process rather than an integral part of it. This strong attitude reported by the participants contributes to leading students and instructors to hold ambivalent beliefs towards errors and to implement inconsistent practices related to error handling during learning activities (Pan et al., 2020).

On the other hand, cross-cultural studies highlighted how beliefs and practices are embedded into and influenced by the broader structural and cultural context (Dalehefte et al., 2012; Eriksson et al., 2020; Wang & Murphy, 2004). Santagata (2004) videotaped lessons in the U.S. and Italian context, finding that U.S. and Italian mathematics teachers deal with students' errors differently according to different teachers' beliefs (which Santagata called *cultural beliefs)* and the characteristics of the lesson. More precisely, the author found that Italian teachers discussed students' errors publicly more often than U.S. teachers. This difference was interpreted as a function of Italian and U.S. teachers' beliefs about students (i.e., students should be driven to do the essential work to learn and students' self-esteem should be reinforced and protected, respectively), and analysing the differences in mathematics lessons (i.e., exercises solved mostly on the blackboard in Italy or students solve them alone in the U.S.).

Along the same line, Schleppenbach and colleagues (2007) carried out a cross-cultural study with Chinese and U.S. teachers and they found that teachers in the two nations handled errors very differently. The Chinese teachers asked more follow-up questions about errors than the U.S. teachers did, who made more statements about errors. Additionally, when questions were used, U.S. teachers tended to ask students to evaluate the response, whereas Chinese teachers asked students to correct or justify the mistake. Furthermore, the authors found the ambivalence of teachers' beliefs in both nations: on the one hand, errors are defined as natural aspects of the learning process that help students understand their limits; on the other hand, errors are described as events that are not always helpful in developing knowledge.

Overall, this evidence provided an overview of teachers' beliefs about errors as mixed and not always linked to teachers' practices. In addition, cultural and structural aspects affect teachers' beliefs and practices related to errors. So far, only one study explored Italian teachers' practices towards errors (Santagata, 2004), without, however, directly focusing on their error-related beliefs. In line with these considerations, the first aim of this study is to explore Italian teachers' general beliefs on the role of errors in learning, and the practices teachers report to use to deal with errors during learning situations in the classroom.

It is also important to highlight that errors may occur publicly, e.g., a student makes an error in front of classmates and the teacher, or privately, e.g., a student makes an error in a task, and only the student and the teacher detect the error and correct it. This distinction is fundamental considering that errors may acquire different meanings according to the rules set in the classroom regarding errors (i.e., error climate; Steuer et al., 2013). Most of the studies presented above referred to general teachers' beliefs about errors (Bray, 2011; Pan et al., 2020; Schleppenbach et al., 2007) and to strategies used during public error situations that occur during learning activities. In this study, we explored teachers' general beliefs about errors, regardless of whether they occur publicly or privately, and their reported practices employed in the classroom when errors are made public.

1.2 The effects of grading on teachers' error-related practices

In her study, Santagata (2004) interpreted differences in teachers' practices towards errors considering the structure of mathematics lessons in the two contexts she observed (Italy and the U.S.). In this study, we focus on an important structural feature of the education system, namely the evaluation of students' performance and achievement (i.e., classroom assessment; McMillan, 2013). Classroom assessment can be broadly divided into formative assessment and summative assessment or grading (Brookhart, 2017). Formative assessment's basic assumption is that the information gathered about students can be used to promote students' learning. Formative assessment assists in identifying learning gaps, scaffolding new learning, anticipating subsequent teaching steps, and fostering students' ability to control their learning (Andrade et al., 2019; Heritage, 2010). In formative assessment, errors are framed as springboards for learning: they are considered signals to understand students' limits and to reconsider teachers' strategies and instruction; they serve as a basis for creating a class discussion and as a starting point to work on students' reasoning (Matteucci et al., 2019).

Conversely, grading is a summative assessment based on applying a simple value-laden symbol (e.g., a letter or a number) to summarise academic performance value. Due to their simplicity, grades allow to easily rank students according to the value of their performance (i.e., the obtained grade, Pulfrey et al., 2011), thereby increasing the normative aspect of assessment (i.e., comparing the performance of a classroom's students, Brookhart, 2004). A wealth of research showed that normative grades have detrimental consequences on students' learning and motivation (Ames, 1992; Hayek et al., 2014, 2015; Klapp, 2015; Poorthuis et al., 2015; Pulfrey et al., 2011, 2013). These consequences may be most likely due to the competitive social comparison

that grades elicit, which may threaten students' self-esteem (Butera, Świątkowski et al., 2021; Muller & Butera, 2007). Differently from formative assessment, when using grading, teachers take errors into account to assess the value of the performance. In this respect, errors and grades are characterized by a negative interdependence: The higher the number of errors in a task, the lower the likelihood of obtaining a good grade (Weingart, 2004). Therefore, this negative interdependence may transform errors from being a stepping stone for learning into a tool for evaluation.

The distinction between formative and summative assessment is linked to the distinction between learning situation and testing situation: During learning, formative assessment provides feedback to students and teachers; during testing, summative assessment helps teachers summarise the students' achievement level (Bennett, 2011; Lau, 2016). However, due to pressure on school accountability, summative assessment is predominant in the Western education systems (Erickson, 2007) and grades have been indeed the most used evaluation tool in OECD countries (OECD, 2013). Furthermore, formative assessment is seldom implemented because teachers find it challenging to use (Bennett, 2011). Italian teachers, for instance, prefer to use summative assessment, by grading their students' tasks and homework, instead of implementing formative assessment (Pastore et al., 2019). In addition, in Italy, every formal evaluation of students' achievement has to be reported with grades, and Italian students are used to receiving grades very often. Since grades are very simple and pervasive, as shown by some experimental studies (Hayek et al., 2017; Pulfrey et al., 2013), using this evaluation may blur the difference between learning and testing situations. In such a context, like the Italian one, the pervasive implementation of summative evaluation and the massive use of grades may challenge teachers in promoting the learning potential of errors in both situations. Accordingly, the second aim of this study was to explore teachers' beliefs about the relationship between grades and errors.

Based on the results and evidence in the literature on teachers' beliefs about errors and their reported error-handling practices, as well as their beliefs about the relationship between grades and errors the present research had two main aims. The first aim was to qualitatively explore teachers' beliefs on the role of errors in the learning process and their practices in handling errors. The second aim was to shed light on teachers' beliefs on the link between errors and grading, a structural feature of the learning environment closely connected with errors. In order to gain evidence on these two aspects, we conducted an exploratory qualitative study based on semi-structured interviews with Italian teachers.

2 Method

2.1 Procedure and participants

The present study is the qualitative part of a broader research project on teachers' well-being and teachers' practices (in particular, error-handling and assessing practices). Participants took part in a quantitative survey on different topics, and, in the end, they could leave their e-mail addresses to be contacted again for the interview.

Teachers who left their e-mail addresses (n = 150 over 1100 teachers who replied to the survey) were contacted by the research team. They were asked to take part in the interview, and they were informed about the interview contents, which were presented clearly and concisely. The participants knew the general aims of the interview, namely understanding their experiences during the lockdown enforced to stop the COVID-19 pandemic (these results are not presented in this paper) and exploring their beliefs related to the error in the learning process and its relationship with the grading system.

Participants were selected according to the school level in which they taught (i.e., primary, middle, or secondary school) and their region (i.e., northern, central, or southern region) to have a balanced sample. Therefore, we selected ten participants for each school level among these teachers, balancing the regions. In the first wave of invitation e-mails, we contacted 30 teachers (15 from the north, 9 from the centre, and 6 from the south according to the total number of teachers in each region) and only 8 teachers agreed to be interviewed. Thus, we contacted other teachers and implemented the same sampling procedure for four weeks.

The final sample comprised 33 Italian teachers (M_{age} = 51.69, SD=7.35, 27 women), divided into the three school levels: primary (n=10), middle (n=10) and secondary (n=13) school. The overall sample comprised teachers with 1–35 years of experience (M=23.30, SD=8.49). Specific characteristics of the three groups of teachers are presented in Table 1.

2.2 The Italian education system

The Italian education system is divided into primary school (for pupils aged between 6 and 11), middle school (for pupils aged between 11 and 13), and secondary school (for students aged between 13 and 18). Each school level is characterised by specific features regarding the schedule, the subjects taught, and the daily activities organisation. Nevertheless, at the moment of the research, the three levels shared the same evaluation system based on grades[1]. An evaluation with grades was required by the Law and was used by teachers to account for students' progress throughout the school year. During classroom learning activities, teachers usually test students' learning levels at the end of each teaching unit. These tests might be written or oral and are graded on a scale between 0 and 10. The average of all these evaluations constitutes the two summative evaluations of the year. In the middle (mid-January) and at the end (mid-June) of the school year, students receive a formal school report, which qualifies for students' achievements. The final assessment at the end of the school year is also used to decide whether the student passes the school grade.

According to the findings of a recent study carried out in Italy (Pastore et al., 2019), Italian teachers tend to use assessment also to control and monitor students, and they focus on the cognitive dimension of students' learning, assessing very often homework, tasks and tests to evaluate their learning achievement more than the pro-

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[1] From December 2020, the evaluation method in Italian primary schools has been changed. Grades have been replaced by descriptive judgements. At the time of data collection, however, primary school teachers used grades for summative and daily assessments.

Table 1 Descriptive Characteristics of the Participants Divided into the Three School Grades

Sample group	N	Age Mean (SD)	Gender	Regions [a]	Years of teaching Range/ Mean (S.D.)	Subjects taught
Primary school teachers	10	49.50 (25.11)	9 women 1 man	7 Northern Italy 2 Central Italy 1 Southern Italy	14–34 20.81 (5.73)	6 Italian and history 1 mathematics and sciences 3 other subjects[b]
Middle school teachers	10	53.21 (6.17)	9 women 1 man	6 Northern Italy 3 Central Italy 1 Southern Italy	16–37 26.71(6.94)	4 Italian 2 mathematics 3 French and English as L2 1 music
Secondary school teachers	13	52.23 (8.63)	9 women 4 men	9 Northern Italy 2 Central Italy 2 Southern Italy	1–35 22.61 (10.77)	4 mathematics 5 Italian and Philosophy 2 laws 2 English as L2

Note. The total sample is 33 teachers divided into three groups, based on the Italian education system division

[a] The regions are Emilia-Romagna (Northern region), Marche (Central region), and Sardegna (Southern region).

[b] In the Italian primary school system, teachers have different roles determined by school regulations. In some schools, two teachers teach the main subjects in the same classroom (i.e., one teacher for STEM subjects and the other one for literature/humanities subjects). In other schools, one teacher (called Main teacher) teaches all the main subjects in each classroom, supported by another teacher (called Support teacher) who teaches other subjects, such as music or physical education. In our primary school sample, 7 teachers were Main teachers of the classroom, whereas three teachers were Support teachers.

cess of achievement. Their conceptions about assessment are mixed and they tend to prefer summative assessment because it is considered clearer, more focused on students' performance than formative assessment and an efficient tool to control students' learning path.

2.3 Data collection and interview protocol

The data collection took place between June and July 2020, after the Ethical Board of the first author's university approved the research. The interviews, which lasted between 30 and 100 min ($M=49.82$, $SD=17.28$[2]), were carried out online, audio-recoded, and transcribed verbatim by three researchers separately. A semi-structured exploratory interview protocol, which covered different topics, was created based on the research questions. For the aim of this paper, we present only the part of the interview protocol related to the study's aims (Table 2).

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[2] Primary school teachers interviews, $M=61.30$, $SD=23.08$; middle school teachers interviews, $M=49.88$, $SD=16,34$; secondary school teachers interviews, $M=37$, $SD=58.16$, SD=25.31.

Table 2 Research Questions and Interview Protocol

Research questions	Interview schedule
/	Personal and professional information
1. What are teachers' beliefs about errors in the learning process?	What is the role of students' errors in the learning process?
	Do you think that your students are afraid of making mistakes?
2. How do teachers describe the way they usually handle students' mistakes during learning activities?	When one of your students makes a mistake in the classroom, how do you usually react to this situation?
3. How do teachers reflect on the relation between students' errors and grading practices?	What is the relationship between students' errors and evaluation in your teaching practice? How do you handle this relationship?

2.4 Data analysis

Transcriptions of the interviews were analysed through reflexive thematic analysis (Braun & Clarke, 2020) which was chosen among other analytical strategies because it is a flexible tool that allows researchers to gain a complex overview of the data (Braun & Clarke, 2006). Since teachers' beliefs about the error-grading relationship (one of the explored topics) have not been studied extensively yet, a flexible tool to identify patterns in a dataset without following any a priori coding scheme (Braun & Clarke, 2006, 2020) was considered the most appropriate.

To carry out the data analysis, we followed a specific procedure, derived from the one proposed by Braun and Clarke (2006). Before dividing the interviews among the researchers, one interview was coded by each of them to understand if the coding procedure was interpreted in the same way by the researchers. Codes were interpreted as an analytic unit that refers to one single and meaningful facet of the phenomenon (Braun & Clarke, 2020), and after this first coding procedure, the three researchers discussed the results of this preliminary process to understand if their coding strategy was similar. After this step, the interviews were divided among three researchers of the team to let them familiarise with a specific part of the data. The division was made based on school level because primary, middle and secondary schools differ in terms of the number of school subjects taught by teachers, the role of teachers in the classroom, the number of classrooms teachers are responsible for, and teachers' schedules in each class. Dividing the data among three researchers was considered an efficient analytical strategy to allow each researcher to code and interpret the data by considering specific features of a particular school grade context.

Then, the three researchers coded the interviews without following any a priori coding scheme, but rather they inductively identified codes in the data (Braun & Clarke, 2020). This inductive approach was rooted in the research questions that guided the analytical process of the three researchers. In other words, the researchers coded the interviews knowing the aim of the research questions and trying to inductively understand the meaning of participants' reports through the lens of the research aims and questions. The three researchers agreed on focusing on the semantic mean-

ing of the data during the coding process, following a more "essentialist/realist" epistemology focused on participants' inner beliefs (Braun & Clarke, 2006, p. 85).

After the first coding procedure, each researcher developed initial themes starting from their coding process. Themes, defined as multi-faceted and complex topics (Braun & Clarke, 2020) with a high degree of generality (Vaismoradi et al., 2016), were created by gathering codes that shared similar meanings considering the research questions (Braun & Clarke, 2006). Fourth, the three researchers shared the codes and themes to find similarities and differences among the data and discussed the initial themes together. This procedure resulted in an ongoing revision of the themes considering the codes that emerged in the coding analysis, and the research questions operated by the three researchers in synergy. Finally, the three researchers agreed on the final themes that provided a general overview of the phenomenon across the three school levels (Table 3). Since the three researchers analysed different interviews, it was not possible to test coding reliability. However, as reported by Braun and Clarke (2020), using reflexive thematic analysis does not require the use of a coding reliability check and a sort of reliability test was ensured at the beginning of the process, where researchers coded the same interview and elaborated a shared coding strategy.

3 Results

A total of seven themes emerged from the data. We present the themes by dividing them into two main levels that reflect the two main areas explored through the interview: *Teachers' beliefs* and *Teachers' practices*. It is important to note that we refer to practices reported by teachers and not observed by the researchers, since we only had access to information provided by the participants during the interviews. In this section, we will present the results and their link with the literature, and then, we will discuss the main contributions of the study in the discussion section. The levels, themes and codes are presented in Table 3.

3.1 Teachers' beliefs level

This level reflects the research interest in exploring what teachers believe about their students' errors and the relationship between errors and evaluation. It comprises four themes that provide an overview of the complex and ambivalent teachers' beliefs on these topics.

3.1.1 Theme 1: Positive and negative teachers' attitudes towards errors

This first theme describes teachers' attitudes towards errors in the learning process. Most of the participants ($n=24$, code 1) clearly expressed positive attitudes towards errors which were described as '*fundamental*' and essential for enhancing learning. This positive attitude mirrors the general positive idea that teachers hold about errors, as shown by previous studies (e.g., Pan et al., 2020). However, some teachers ($n=9$, code 2) stated that if errors are reiterated, they may hamper learning. The repetition

of the same error is defined as a '*loss in the learning process*' and the cause of this repetition may be found in the lack of students' commitment and study:

'*The error has a positive value, not negative, that is for sure. It becomes negative if it is repeated and done because you (the student) did not want to study. But if it is the starting point to recover and to look at what you can do better… then it is ok.*' (primary school, 53 years, female).

Most of the participants presented a mixture of attitudes, expressing both positive and negative aspects of making errors (see the quote above). Only one teacher linked the positive attitude toward errors to a specific moment of the learning process, and after this moment errors are negative and should be not considered in the learning process:

'*The error for me is important but at a very early stage: when I explained the topic. Then the error remains something that one has not been able to process. If I focus too much on the error, I clearly neglect those aspects of learning that need positive feedback.*' (secondary school, 43 years, female).

In sum, the attitudes towards errors that teachers reported could be broadly divided into positive and negative. These different attitudes are linked to students' approach to learning: Errors due to a lack of students' effort and commitment, which may hinder learning, are related to a negative attitude whereas errors due to a lack of students' understanding, which supports learning, are linked to a positive attitude. As already found by other scholars (e.g., Schleppenbach et al., 2007), teachers hold different and sometimes mixed attitudes towards errors. What is new is the link between these attitudes and ideas of students' different approaches to learning.

3.1.2 Theme 2: Roles of errors in the learning process

This theme represents the teachers' beliefs on the different roles errors might play in the learning process and it is closely connected with the previous one, but they differ in focus. Theme 1 reports codes related to teachers' attitudes about errors in general, whereas Theme 2 includes codes on the practical role of errors in the learning process, namely how errors support (or not) learning according to teachers. In line with the previous theme, most of the participants ($n=20$, code 3) stated that errors act as a resource for improving learning. They described errors as signals that students need to revise their knowledge and skills, and errors as a useful tool to highlight students' flaws. Furthermore, some of the teachers ($n=13$, code 5) recognised that errors have a useful role also for themselves, as a sign that something in the teaching practices and instruction should be changed.

'*An error is useful because it lets me see where my explanation of the topic was not clear enough and where I couldn't reach the pupils who made a mistake.*' (primary school, 57 years, female).

A few middle and secondary school teachers ($n=6$, code 4) highlighted the educational role of errors, stating that errors help students understand and accept their limits. Overall, these positive roles of error in promoting learning expressed by the teachers are in line with those already reported in previous research (e.g., Bray, 2011; Pan et al., 2020).

Table 3 Levels, Themes, Respective Codes and the Number of Teachers Who Reported Each Specific Code (Total Sample and Sample Divided into the School Levels)

Levels	Themes	Codes	Total number of teachers (N=33)	Primary school teachers (N=10)	Middle school teachers (N=10)	Secondary school teachers (N=13)
Teachers' beliefs level	1. Positive and negative teachers' attitudes towards errors	1. Errors fundamental for learning (positive attitudes)	24	8	7	9
		2. Errors are negative if reiterated (negative attitude)	9	4	4	1
	2. Roles of errors in the learning process	3. Errors as a source for learning and reflection	21	9	4	10
		4. Errors highlight that every student has limits (educative role)	6	/	2	4
		5. Errors help teachers to modulate instruction and teaching practices	13	5	3	3
		6. Error helps students who want to learn from them	16	3	7	7
	3. Students' threatening errors perception	7. Errors are frustrating	8	4	1	3
		8. Fear of disappointing the teacher	4	2	1	1
		9. Fear of disappointing parents	5	3	1	1
		10. Fear of being judged by others	10	3	2	5
		11. Students' personal features (i.e., shyness)	16	4	5	7
		12. Past experiences	6	2	1	3
	4. Imbalanced inter-dependence between errors and grades	13. Negative relationship between errors and grades	15	7	1	7
		13a. Errors must be evaluated	10	2	3	5
		13b. Errors became the projection of a bad grade	5	1	2	2
		14. Errors and evaluation relationship not balanced	7	4	1	2

Table 3 (continued)

Levels	Themes	Codes	Total number of teachers (N=33)	Primary school teachers (N=10)	Middle school teachers (N=10)	Secondary school teachers (N=13)
Teachers' practices level	5. Supportive and discouraging error-handling practices	15. Negative reactions only for students' lack study/commitment	13	4	5	4
		16. Encouraging, supporting students in finding a solution	26	9	7	10
		17. Class correction of the error (class discussion)	12	6	4	2
		18. Reaction changes according to the situation	6	2	2	2
	6. Strategies to mitigate students' threatening perception of errors	19. Avoiding stigmatization	11	4	4	3
		20. Reassuring pupils/Creating a positive climate	15	5	2	8
		21. Contextualising and framing pupils' mistakes	4	2	2	/
		22. Using Irony	7	1	3	3
	7. Dealing with the negative interdependence between errors and evaluation	23. Sharing evaluative criteria with pupils	10	6	2	2
		24. Explaining the grade and giving it a meaning	18	8	6	4
		25. Giving the tasks without a mark, or after the correction	8	2	4	2
		26. Emphasising more learning and errors than test and evaluation	5	2	3	/

'The role of errors is to get students used to being humble because students now-adays think they are "know-it-all" (an Italian way of saying, "nato imparato", a hyperbole meaning that they already know everything at birth, ed.), and it is not good at all. Focusing on mistakes leads you to accept your limits.' (secondary school, 54 years, female).

A particular aspect that emerged from this theme is that several teachers ($n=16$, code 6) reported that errors effectively support learning only if students understand them and are interested in working on them. While describing the roles of errors in the learning process, teachers differentiate between students who are engaged in their learning path and students who are not.

'[The possibility to learn from errors, ed.] depends a lot on the willingness: if the student does not care, then he/she does not tell you and the next time in the test he/she gets the same thing wrong. Those students who take the lesson seriously, on the other hand, will eventually ask you to work on it, and so in most cases, it will work.' (middle school, 53 years, female).

This belief revealed the idea that students are responsible for their learning and the teacher is only a guide that 'leads students to work on their errors'. This aspect mirrors Santagata's (2004) results on Italian teachers' ideas about students. According to the author, Italian teachers hold the belief that students are responsible for their learning and teachers have to push them to work harder. As in the previous theme, teachers' beliefs are differentiated based on students' effort: Errors have a generally positive role, but if the student does not strive to learn from them, their potentially beneficial role is no longer effective.

3.1.3 Theme 3: Students' threatening errors perception

This theme encompasses codes mainly related to the question "Do you think that your students are afraid of making mistakes?". This question was asked to understand teachers' beliefs and awareness of their students' reactions towards errors, which are related to the perception of being in an error-friendly environment (Steuer et al., 2013; Soncini et al., 2022).

What emerged from the analysis is that some teachers ($n=8$, code 7) clearly stated that making errors is frustrating for their students.

'It is difficult to make the students understand the positiveness of making errors because for them an error is a "stab in the back", it means "Oh no, I am inadequate".' (secondary school, 63 years, female).

In addition, some teachers put themselves in the students' shoes and reported several reasons why students might be afraid of making errors. More precisely, most of the teachers ($n=16$, code 11) found the causes of this sense of frustration in the students' internal features, such as shyness, passivity, insecurity, or disinterest.

Other teachers reported causes that are more related to the possible negative consequences errors may lead to. More precisely, some teachers reported that students might be afraid of being judged by others (i.e., classmates; $n=10$, code 10), disappointing the teacher ($n=4$, code 8) and parents ($n=5$, code 9) when they make errors. The PISA survey results about students' well-being (OECD, 2019) showed that 56% of the students in OECD countries reported that they *are worried about what others*

think about them when they err. Being negatively judged by other people is a consequence related to the social connotation of making mistakes (Billett, 2012), and our findings highlight that teachers are aware of this feeling related to the social connotation of errors.

Finally, parents' expectations and past teachers' behaviour were also listed as possible external causes (*n*=6, code 12). It is interesting to note that teachers reported causes related to external or internal features of students (i.e., classmates' judgments) without however considering their teaching practices.

3.1.4 Theme 4: Imbalanced interdependence between errors and grades

This last theme of the Teachers' beliefs level revealed how teachers reflected on the relationship between students' errors and grades. Several teachers (*n*=15, code 13) recognised that errors are linked with negative grades. Delving into this code, it emerged that according to some of these teachers (*n*=10, sub-code 13a), grades are a deeply rooted feature of the school system, and their role includes grading students' tests. For instance, teachers said that errors must be considered when grading during testing situations because '*Grades must be used at school*' and '*Errors have a weight in an objective test.*'. This important role assigned to grading evaluation mirrors Pastore and colleagues' (2019) results, which showed that Italian teachers prefer to use summative assessment (i.e., grading) because it is considered more objective and useful to control students' learning in a structured way.

What is interesting and unexpected is that when teachers refer to the whole learning process, considering learning through a formative approach where errors have a useful role in learning, they (*n*=5, sub-code 13b) expressed their difficulties in accepting this negative interdependence and dealing with it.

'Errors in our system of grids, objectivity, with parents assessing you, controlling you, is very brutal. One error is equal to one point less in the evaluation. I say that clearly. This is because the school system requires it. […] For instance, the student who proved me that he/she has made progress, but he/she has also made mistakes, I cannot emphasize his/her work (giving a good grade, ed). *The system does not allow me to do so.*' (secondary school, 54 years, female).

Furthermore, some teachers (*n*=7, code 14) added further information related to the error-grades interdependence: It might have a negative direct consequence on students. According to them, their students are more interested in knowing their grades than understanding the errors, and thus, errors may lose their role in fostering learning. Consequently, the negative interdependence between grades and errors is *imbalanced* to the extent that students focus more on grades than on errors when they are evaluated. Most likely, the normative aspect of grades (Brookhart, 2004) makes salient the social comparison among students (Muller & Butera, 2007), focusing their attention more on the received grade than on errors. This imbalance is particularly salient when teachers referred to testing situations, where grading is salient, as expressed in the quote below.

'Even though at middle school students are told "You learn by making mistakes", teachers grade the students' tests, and students only focus on that. It works like that.' (middle school, 49 years, female).

In this theme, a discrepancy between different beliefs on the approach to the errors-grades interdependence emerged. Teachers acknowledged the negative interdependence between grades and errors because in testing situations errors become a tool for grading the test. On the one hand, some teachers expressed the importance of using grades as an objective evaluation tool to assess students' tests and tasks. On the other hand, other participants reported a mismatch between stressing the positive role of errors and negatively counting errors in the assessment of the performance tasks. This situation poses a challenge for teachers who believed that errors are important aspects of the learning process. The unbalance between grades and errors that teachers highlighted is in line with research on the pervasive effects of grading on students (Hayek et al., 2015; 2017; Pulfrey et al., 2013).

3.2 Teachers' practices level

This level refers to the set of reported behaviours, affective reactions and teaching strategies teachers reported adopting when an error occurs during a lesson, and it is divided into three themes. These themes are closely related to those of the previous level, and they enrich the understanding of teachers' beliefs by adding information about their practices related to errors.

3.2.1 Theme 5: Supportive and discouraging error-handling practices

This theme comprises all the strategies teachers said they usually implement when students make mistakes during daily class activities. The teachers of our sample reported using several supportive error-handling practices to help students understand and overcome errors. For instance, most of the teachers ($n=26$, code 16) reported that they support the student who made the error in understanding it and finding a solution. Primary school teachers often reported using a strategy like '*going hunting for errors*' while correcting written exercises and oral tests.

'*Depending on the age, it is good to point the error out, not correct it. While correcting text, I put a dot next to the sentence if there is an error. Then I say to the student: "Look for the error". If the student finds the error, we correct it.*' (primary school, 47 years, female).

Differently, middle and secondary school teachers stated that they support students in rethinking the error with a step-by-step procedure to revise the mental procedure implemented to answer. Furthermore, several teachers ($n=12$, code 17) reported involving the classmates to start a class discussion to correct the error together. Overall, these supportive practices mirror the adaptive error-handling strategies Tulis (2013) observed in German teachers and the reflection approach towards errors proposed by Heemsoth and Heinze (2014).

Other teachers ($n=6$, code 18) stated that they react differently according to the kind of errors, and some other participants ($n=13$, code 15) reported that when they understand that errors are due to a lack of effort, their reactions change, becoming harsher, and they get irritated. They described this reaction as spontaneous and, to some extent, necessary.

'*If students had to study and they do not know, for instance, the verbs because they did not study, then, in that case, I get angry.*' (middle school, 51 years, female).

These negative reactions towards errors are similar to the maladaptive error-handling strategies Tulis (2013) observed in her study. These negative reactions might contribute to the establishment of a negative error climate in the classroom, which is related to teachers' negative reactions towards errors and not supportive practices (Steuer et al., 2013).

It is important to note that these practices refer to public error situations that happen during learning moments in the classroom. Indeed, teachers were asked "When one of your students makes a mistake in the classroom, how do you usually react to this situation?", and so they specifically focused on this situation. Similarly, to the attitudes (Theme 1) and the role of errors (Theme 2) reported by the teachers in the previous level, in this theme, teachers reported adopting different error-handling practices to deal with students' errors. Again, the main distinction is based on the kind of errors that occurred (i.e., errors due to a lack of understanding or a lack of commitment).

3.2.2 Theme 6: Strategies to mitigate students' threatening perception of errors

This theme refers to several strategies that teachers said they use to make students perceive their errors positively. As for Theme 3, Theme 6 encompasses codes that emerged from responses to the question on the students' fear of making errors. Teachers considered that errors are frustrating for students, and starting from this idea, they also provided information about strategies they usually implement to prevent students to feel this frustration.

Most of the teachers ($n=15$, code 20) reported that they tried to create a positive classroom climate in which students are not judged if they make an error. For instance, teachers discouraged classmates' negative reactions after errors and reassured students and pupils to prevent them from being demotivated.

'*First of all, I create an atmosphere as positive as possible. […]. I just listen to the students, and I tend to let them express themselves, to let them make errors. Then, in a way that I think is appropriate depending on the student's personality, I start to point out what didn't work.*' (secondary school, 66 years, male).

Linked to this strategy, teachers ($n=4$, code 21) reported that they tried as much as possible to '*frame the error as a useful signal*', and to avoid errors stigmatisation and personalisation by correcting the error in a respectful and calm way ($n=11$, code 19).

'*Even when correcting writings test, for example, I take sentences from their essays - without saying who made that error - and then work on them on the blackboard asking: "What do we need to do to improve this?".*' (secondary school, 64 years, female).

Finally, some teachers ($n=7$, code 22) said to use irony to decrease the frustrating meaning errors might bring.

'*I am very ironic. I use irony because I know making errors is frustrating.*' (middle school, 57 years, female).

Overall, the practices teachers reported in this theme are similar to those already found in the literature. For instance, the irony trait of teachers' responses was high-

lighted also by Santagata (2004) and it is most likely a cultural aspect that influences how teachers deal with students' errors. The other practices mirror supportive/mitigating practices already found in observational studies (Tulis et al., 2013; Santagata, 2004) which may lead to the establishment of a positive error climate (Steuer et al., 2013).

3.2.3 Theme 7: Dealing with the negative interdependence between errors and evaluation

As shown in Theme 4, teachers recognised the negative interdependence between errors and grades that leads students to focus more on grades than on understanding errors. Teachers said they adopt several strategies to mitigate the negative effects of grading on the potentially positive role of errors.

Most of the teachers ($n=18$, code 23) deal with this interdependence by explaining both grades and errors carefully to the students and by sharing evaluative criteria before the test ($n=10$, code 24). In this way, the positive role of errors in supporting learning by highlighting what should be improved may still emerge.

'*But the main thing is to explain these errors. A negative grade must serve as a signal to improve the next time. You always have to show the positive side. Then students also need to see what they did wrong and have a picture of a moment that is useful to understand what they have to do.*' (middle school, 51 years, female).
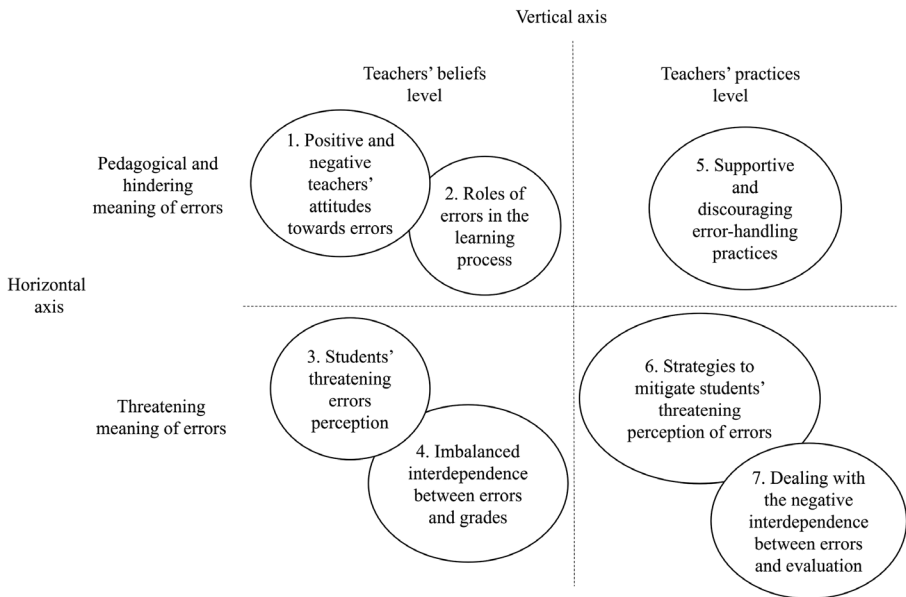
To prevent students to focus only on grades and not on errors, some teachers ($n=8$, code 25) said they decided to separate the handing out of the test results from its evaluation or clearly emphasise errors more than the grade ($n=5$, code 26).

'*For a couple of years now, we have decided that the students don't see the grade on the test, because it triggers anxiety and competition […] and they completely lose focus, which is a mistake… they just look at the grade.*' (middle school, 49 years, female).

In this last theme, teachers' activities and strategies to deal with the negative interdependence between errors and grades emerged. Since teachers must evaluate their students through grades, they found their own teaching practices to support students in considering and using errors as a stepping stone for learning.

4 Discussion

This study was set to qualitatively explore teachers' beliefs about errors in the learning process and the error-handling practices teachers reported adopting during daily activities. Furthermore, the study shed light for the first time on teachers' beliefs about the error-grade relationship, because grading is crucially important in the Italian education system. A total of thirty-three Italian teachers' interviews were analysed through reflexive thematic analysis, and seven themes emerged from the data. Here, we discuss the two main contributions of this paper, examining the extent to which they inform our research questions and the new insight they provided to the literature on teachers' error-related beliefs and practices. In Fig. 1, an overview of the themes and their interconnections is provided.

Vertical axis

Teachers' beliefs
level

Teachers' practices
level

Pedagogical and
hindering
meaning of errors

1. Positive and
negative
teachers'
attitudes
towards errors

2. Roles of
errors in the
learning
process

5. Supportive
and
discouraging
error-handling
practices

Horizontal
axis

Threatening
meaning of errors

3. Students'
threatening
errors
perception

4. Imbalanced
interdependence
between errors
and grades

6. Strategies to
mitigate students'
threatening
perception of errors

7. Dealing with
the negative
interdependence
between errors
and evaluation

Fig. 1 The Seven Themes Extracted through the Thematic Analysis
Note: The seven themes have been arranged as a function of two axes. The vertical axis originates in our research questions and the tension between teachers' beliefs and practices. The horizontal axis pertains to the functions of errors that emerged from the results

4.1 Different meanings of errors in the learning process

The first contribution of this study is that it provides new insights into teachers' error-related beliefs. According to our findings, beliefs about errors differ considering the different roles errors may play in the learning process. These roles change according to teachers' beliefs about students' commitment to their learning path and grading evaluation system. Furthermore, the error-handling strategies reported by the teacher might be interpreted in the light of the specific meaning errors acquire.

When teachers expressed their general beliefs about errors and their roles in learning, errors carried a *pedagogical meaning*. Teachers reported their positive attitudes towards errors due to a lack of students' understanding (Theme 1) and recognised the supporting role of errors for learning because they have a pivotal role in improving learning and instruction (Themes 2). In line with this belief, teachers also reported using supportive practices in dealing with this kind of error: They described supportive and encouraging strategies used to help students learn from their errors (theme 5). The pedagogical meaning of errors has been already found in the literature by Bray (2011) and Pan and colleagues (2020). These authors described that teachers and instructors hold positive ideas about errors, considering them as a tool for improving learning. Furthermore, the supportive practices our sample reported are similar to those observed by Tulis (2013), such as discussing errors with the whole class, or those proposed by Heemsoth and Heinze (2014) which constitute the reflection teaching approach based on analysing the error to understand it and learn from it.

Enlarging the focus, the pedagogical meaning of errors can be linked to teachers' beliefs about the constructive learning approach (a student-centred approach where students are supported in generating questions and finding solutions; see Ambusabi & Al-Balushi, 2012). This kind of approach is different from the transmissive approach (i.e., teacher-centred approach where learning is based on conveying knowledge to students) and includes the constructive exchange between teachers and students to build new knowledge. These teachers' beliefs may be linked to the pedagogical meaning of errors since errors become part of the learning process.

On the contrary, errors acquire a *sanctioning meaning* when, according to teachers, they are due to a lack of student commitment. In this case, teachers expressed negative attitudes (Theme 1) and errors are considered detrimental to learning (Theme 2). While expressing the sanctioning meaning of errors, teachers did not focus only on testing situations, where errors become salient for the evaluation, but they referred also to the learning situations. Indeed, they did not differ among the two situations, because what gives sense to this meaning is linked to teachers' beliefs about students' intention to commit or not in their learning path. In line with this belief, teachers reported using more negative practices, such as scolding the student and penalising the error (Theme 5). This result mirrors Santagata's (2004, p. 158) findings, which showed that Italian teachers hold beliefs (i.e., cultural beliefs) that students "should be pushed to do work necessary to learn" and are responsible for their own learning. Therefore, if they do not strive to succeed, teachers are justified to consider their errors reprehensible. This explanation reflects the attributional process described by Matteucci and Gosling (2004): When teachers attribute failure (making errors) to students' lack of effort (i.e., personal internal responsibility), the consequent emotional reaction is negative (i.e., anger), which leads to reprimanding students. This external defensive attribution of teachers allows them to deflect responsibility for students' failure from themselves to the students.

Finally, when teachers put themselves in the students' shoes, they reported that students might be afraid of making errors because errors are viewed as threatening cues that increase frustration and negative emotions (Theme 3). In this case, errors acquired a *threatening meaning* which could be interpreted as the consequence of the social connotation of errors (Billett, 2012). Since teachers recognized this threatening meaning, they reported implementing strategies to decrease students' frustration and fear of making errors (Theme 6). Teachers provided several explanations about why errors may become threatening for students by listing internal (i.e., the student's personal features) and external (i.e., social pressure, parents' expectations, and evaluation, of course, evaluative pressure) causes. It is interesting to note that, among external factors, teachers reported factors that do not include their own practices. This result is in line with Matteucci's (2007) findings, according to which teachers do not ascribe to themselves students' failure. One possible explanation could be that it is common to use more external than internal explanations for negative events (i.e., self-serving attributional biases; Mezulis et al., 2004). Considering making errors as something that should be avoided, or, at least, that may increase students' fear, teachers may prefer to give external explanations to preserve their own self-esteem and self-concept. This threatening meaning is evident during learning situations, when students do not want to raise their hand because they are afraid of others' judge-

ment, and it is exacerbated during testing situations. Indeed, teachers acknowledged the negative interdependence between errors and evaluation, of which teachers were aware (Theme 4). In this case, although some teachers believed that grades are an important tool for assessing students, they reported implementing specific strategies to stress the pedagogical meaning of errors during testing situations (Theme 7).

4.2 Normative grading may hamper the possibility of framing errors positively

The second contribution of our study is related to the threatening meaning of errors described in the previous paragraph. For the first time, this study explored teachers' beliefs about the grade-error relationships and, consequently, delved into new shades of the teachers' beliefs about errors. First of all, our results showed that some teachers found the grading evaluation system as an efficient tool for assessing students in testing situations because it is objective (Theme 4). This result is in line with Pastore and colleagues' (2019) findings, which showed Italian teachers prefer and adopt summative assessment more than formative assessment because it is considered a tool to control better the students and more objective in assessing their performance.

Conversely, some other teachers expressed their difficulties in stressing the positive role of errors while grading during testing situations. This ambivalence mirrors the double function of educational systems: educational, which assures that all students have access to the same opportunities; selective, which is aimed at rewarding and tracking students according to their performance (Darnon et al., 2009). Teachers have, therefore, a double role while teaching: they act as mentors (they educate) and as gatekeepers (they select; Butera, Batruch et al., 2021). The educational role is best pursued by using formative assessment (e.g., Black & Williams, 2018), whereas the selective role is achieved through normative grades (Autin et al., 2015, 2019). Teachers tend to adapt to the requirements and features of the education system in which they work, and they tend to accentuate their role as gatekeepers instead of as educators (Butera, Świątkowski et al., 2021)to fulfil the selective function of education systems. In line with that, our findings suggested that teachers recognized the detrimental effect of the grading system when their instructional goal is to support students' learning. In this case, teachers reported that they have to make an extra effort to stress the pedagogical meaning of errors when using grades, by developing particular teaching strategies (Theme 7). On the contrary, some teachers said that errors must be considered while grading: only deserving students should be positively graded, whereas students who make errors for whatever reason should receive a bad grade. In this way, teachers fulfil their selective role, also risking perpetuating a negative idea of error as an event that should be avoided.

4.3 Limitations and future research

The first limitation of this study is that the data collection was based on interviews only. The teachers in the sample were not observed, which limited the possibility of exploring teachers' practices with a triangulation of methods. Furthermore, in interview-based research, social desirability may be at work. To limit this bias, we used different strategies: the interviewers were trained to prompt and ask clarifications to the participants for each

sensitive question; the interviews were carried out online and not in a public space where other people could listen; the participants were informed about the interview contents and the procedure for anonymising the data (see Bergne & Labonté, 2020). Despite the use of these strategies, it is important to acknowledge that the bias may have affected the results.

The second limitation refers to the sample. Because of the wide range of teacher profiles (school level and subjects), we could not analyse the data by the type of subject taught. It has already been shown that errors bring different meanings and consequences depending on the subject. For instance, the literature about classroom error climate has demonstrated that students' perceptions of and beliefs about errors change as a function of school subjects (Steuer et al., 2022; Tulis et al., 2018). Consequently, it is plausible to argue that teachers hold different error-handling strategies as well as different beliefs about errors depending on the school subject they teach.

A third limitation concerns the possible influence of the COVID-19 pandemic on the results since the study was carried out immediately after the school year influenced by four full months of school closures. Although teachers were asked to focus on their general beliefs and to report the practices they used to implement before the pandemic, their responses might be influenced by the stressful situation they faced during the school closures.

Finally, the fourth limitation is related to the exclusive focus on teachers' points of view and not on students' beliefs. Some of our results described teachers' beliefs about the students' perspectives without any corresponding insight into the students' thoughts and beliefs. Future studies should also explore students' beliefs related to errors and evaluation to combine and compare the teacher's and the students' perspectives.

In line with these limitations, we think that future research should also access teacher practices and combine observational results with interviews or focus groups, as well as explore students' points of view of errors and how teachers deal with their errors both in situations where errors are public and where errors are private. Furthermore, future research may deeply explore some aspects not completely covered by this study, such as differences in teachers' beliefs and practices related to the school subjects and why teachers reported internal and external causes to explain students' fear of making errors (Theme 3).

Despite these limitations, this study contributed to the literature by providing more nuanced facets of teachers' beliefs about errors, linking them with teachers' ideas about students' commitment to learning. In addition, although this study cannot establish a causal link between beliefs and practices, it poses the basis to reflect on this link. The practices reported by the teachers could be interpreted in light of the different meanings of errors, expression of teachers' beliefs about errors. This idea is in line with the conceptualisation of teachers' beliefs proposed by Fives and Buehl (2011) and Skott (2015). Finally, this study explored, for the first time, teachers' beliefs about the error-grade link, showing that grades may be a factor that obstacle the potential positive beneficial role of errors for learning due to their imbalanced negative interdependence.

Declarations

Competing interests The authors report there are no competing interests to declare.

Ethics approval Before starting the data collection, the first' author University Ethical Committee approved the study (protocol 2870, date 29/05/2020).

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