How did the Chinese teacher respond to students' errors in classrooms: A video-based study of mathematics lessons of Mr. Yinglong Hua

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Little attention has been paid to how mathematics teachers from developing countries respond to students' errors. This research applied video-based observation to investigate how a Chinese expert mathematics teacher, Mr. Yinglong Hua, responded to students' errors by analysing four videos of his mathematics classes. There were several findings: Firstly, the framework of teachers' responses to errors needs to be adjusted in different cultural backgrounds. Secondly, the characteristics of Mr. Hua's responses were summarised as: a) Mr. Hua had more adaptive responses than maladaptive responses. b) The categories of his responses to errors were diverse. c) Almost all adaptive responses occurred except waiting. d) No maladaptive responses happened except correction by the teacher. Thirdly, the pattern of Mr. Hua's responses might be affected by many factors. Hence, it is necessary to analyse teachers' responses to errors in a realistic and specific situation.

Keywords: video-based observation; primary mathematics; Chinese expert teacher's responses; errors

Introduction

The educational potentials of learning from errors have been clarified in different cultural backgrounds such as the Chinese old saying"失败是成功之母" (Shī bài shì chéng gōng zhī mǔ) which means failure is the mother of success, English proverbs like "Mistakes are the best teachers", as well as German proverbs like "Aus Fehlern wird man klug" (You will learn from mistakes) (see Kartika, 2018). In research, the importance of errors in learning has also received much attention since the 1980s. Different from prior researchers who regarded mathematical errors as signals that something has gone wrong during the learning process and that remediation is required, Borasi (1987) claimed that mathematical errors should be seen as "springboards for problem solving and problem posing and as grist for critical thinking on the nature of mathematics itself" (p.2). Since then, more attention has been paid to the important role of errors in mathematics learning.

Literature review

Although the educational potential of errors and teachers' responses to errors in classrooms has received some attention from researchers, the literature on the topic of teachers' responses to students' errors is rather limited. For the literature review which was based on English research literature, only eight related empirical studies in English were found and presented on this topic.

Table 1: Specific information of eight relevant studies

Article	Site	Subject	Teachers	Students	Data Collection
Santagata (2004)	Italy and U.S.	Mathematics	Teachers from elementary schools	Grade 8 students in Italy and the U.S.	Video-based observation and discourse analytic approaches
Schleppenbach et al. (2007)	China and U.S.	Mathematics	24 Chinese teachers and and 17 American teachers	Students of Grade 1, 4, and 5	Video-based observation and follow-up interviews
Tulis (2013)	Germany	Mathematics, German, Economics	Mathematics, German, and Economics teachers	Students ranging from grade 5 to grade 13	Direct and video-based observation, questionnaires
Gardee (2015)	South Africa	Mathematics	A mathematics teacher	N/A	Video-based observations
Tainio & Laine (2015)	Finland	Mathematics	Mathematics teachers	Grade 6 students	Video-based observations and conversation analysis
Ingram et al. (2015)	UK	Mathematics	Eight mathematics teachers	Students in secondary schools	Video-based observations and conversation analysis
Alvidrez (2019)	Mexico and U.S.	Mathematics	Secondary mathematics teachers	Secondary school students	Questionnaires, observation, and interview
Soncini et al. (2020)	Italy	School programme subject	An experimenter	108 Grade 5 students	Questionnaires

According to these studies, there are some common characteristics. Firstly, they applied similar research methods such as observation and questionnaires to collect data. The research of Soncini et al. (2020) is the only one which conducted an experimental research design. Secondly, most of the participants are from developed countries such as the U.S., Finland, Italy, the U.K., and Germany. Only two developing countries, a South African country and China, were involved in two studies (Gardee, 2015; Schleppenbach et al., 2007). What is more, cultural differences in teachers' responses to errors among different countries have also been discussed and need to be further investigated in the future. Thirdly, some researchers have developed frameworks of teachers' responses to errors (e.g. Alvidrez, 2019; Schleppenbach et al., 2007; Tulis, 2013). However, there is no widely recognized and used framework at present. Taking the effects of cultural differences on the meanings of teachers' responses into consideration, frameworks need to be adjusted to meet the demands of research in different cultural backgrounds. Fourthly, similar findings are presented in these studies. For instance, some researchers propose that adaptive teachers' responses are more common than maladaptive teachers' responses during daily teacher-student interactions (Schleppenbach et al., 2007; Tulis, 2013; Tainio & Laine, 2015; Gardee, 2015). Nevertheless, more research should be conducted with stricter control over variables as well as larger samples in different countries to examine the validity of these findings. By contrast, Chinese research literature on error-management of mathematics teachers is more limited and mainly focused on possible reasons for students' errors and the importance of making use of errors. More

empirical research is needed to investigate error-handling strategies of primary school teachers and expert teachers.

Research questions

Based on the literature review, it can be concluded that the topic concerning the responses to errors of mathematics teachers from developing countries needs to be further investigated. For this research, I explored how a Chinese expert teacher, Mr. Yinglong Hua, responded to students' errors in primary school mathematics classrooms. Accordingly, my research questions were:

1. How did the expert Chinese teacher, Mr. Yinglong Hua, respond to students' errors in primary school mathematics classrooms?
2. What are the characteristics of Mr. Hua's responses to students' errors in primary school mathematics classrooms?
3. What are the possible reasons for Mr. Hua's responses to students' errors in primary school mathematics classrooms?

Methodology

Selection of the research participant

In this case, I applied the purposive sampling technique in my research and selected Mr. Yinglong Hua as the case with the rationale that "the researcher selects cases she or he can learn the most from" (Teddlie & Yu, 2007, p.84). As a whole, Mr. Hua was selected for three reasons: First of all, he has taught mathematics for more than 30 years and has rich experience in mathematics instruction. He is excellent at teaching mathematics and has won a great reputation as a mathematics educator and a researcher in China. Based on the experience of Mr. Hua and the definition which defines expert teachers as teachers "who had a senior position (advanced and above position) with more than 10 years of teaching experience" (Huang & Li, 2012, p.423), Mr. Hua can be seen as an expert teacher. Secondly, he pays much attention to the educational potential of students' errors in mathematics classrooms and has systematically clarified his transforming error strategy in his publications. Thirdly, his videos of teaching have been recorded and released online to the public for research and study with his consent and approval. At the same time, he has published more than 400 articles and several books, which makes it possible to analyse his error management behaviour and strategies and make comparisons between his beliefs and his educational practice.

Method of data collection

The video-based observation was applied to collect data for my research. As introduced by Somekh and Lewin (2005), observation can elaborate on the presence in empirical settings as well as recording researchers' impressions of what is going on. For my research, observation can be a good choice to collect data and present how an expert teacher responded to errors in actual settings. Also, it was difficult to collect data in actual classrooms with direct observation because of the pandemic situation. Hence, I decided to conduct a structured non-participant video-based observational research in a relatively naturalistic observational setting (it was not a totally naturalistic setting because all participants realised their class was recorded by

cameras and watched by many people when they were having the class, which was rather different from normal classes in daily classrooms) by acting as an observer.

Analytical framework

In this research, Tulis' (2013) framework of teachers' responses to students' errors was chosen and revised as the analytical framework since it not only clarified the link between teachers' error management behaviour and its potential effects on students' attitudes toward errors but also listed explicit types and concrete examples of teachers' responses in errors. As discussed in the literature review, cultures would have effects on the interpretation of the meanings of teachers' responses. It is necessary to revise this framework to meet the demands of my research within the Chinese cultural background. By combining my learning and teaching experience as well as consulting some of my colleagues and researchers in mathematics education, I revised the framework in two aspects. Firstly, I classified all the responses into two categories (adaptive responses and maladaptive responses). Secondly, "correction by the teacher" was categorised as a maladaptive response rather than an adaptive response, while "redirecting the question to another student" was categorised as an adaptive response but not a maladaptive response (see Table 2).

Table 2: My initial revised framework of teachers' responses to errors (changes were in bold font)

	Category/Type of response	Definition/Examples
Maladaptive responses	[1] Ignoring mistake	The teacher ignores the mistake, switches without any comment to another topic
	[2] Criticizing student	The teacher is angry, negative evaluation of the student's mistake
	[3] Humiliating/laughing	The teacher laughs, makes jokes of the student's answer, humiliates the student
	[4] Disappointment or hopelessness	The teacher is upset, shaking his head, grimacing with pain
	[5] Correction by the teacher	**The teacher states the correct answer — the error is directly solved by the teacher**
Adaptive responses	[6] Redirecting the question to another student	The teacher picks another student to correct the mistake made by the first student ("Bermuda triangle of error correction")
	[7] Discussion with the whole class	The teacher starts a discussion with the whole class, asking the whole class for (different) solutions
	[8] Correction by the student	**The teacher repeats the question and/or gives a hint to the student in order to get the correct answer (error correction is returned to the student who made the mistake)**
	[9] Waiting	The teacher waits at least 5 s without reformulating the question or giving a hint
	[10] Emphasizing the learning potential	The teacher praises the student's thought or approach, highlights positively the student's active contribution, emphasizes the learning potential of the mistake
	[11] Impeding negative reactions from class	The teacher stops negative reactions from classmates (e.g. laughing) and turbulences

Sampling procedures

For the research aim of this study, I turned to the website *Jiao Shi Wang* (https://www.sp910.com/) which is a famous website in China and is used to share teaching videos of teachers especially those famous expert teachers in different subject domains. I managed to select teaching videos of Mr. Hua with the following

criteria: First of all, I chose videos of Grade 4, Grade 5, and Grade 6 (11-13 years old) since I have taught mathematics to students of these grades before, which would enable me to decide whether a student's response is right or wrong more accurately. Secondly, I chose videos that present clear voices and high-quality images so that I can tell the movements and facial expressions of participants easily. Thirdly, as teachers' responses to students' errors in classrooms might be related to the characteristics of the topic (Tulis, 2013), I only selected videos on the topic of numbers and algebra. Based on the criteria, four videotaped mathematics lessons of Mr. Hua were finally selected.

Findings

Based on the analysis of four mathematical classes of Mr. Hua, my research presented several following findings. First of all, as the teacher-student interactions follow certain social norms and sociomathematical norms, the framework of teachers' responses to students' errors needs to be adjusted when it is applied in different cultural backgrounds. Meanwhile, as error-management strategies of teachers may vary from person to person, characteristics of certain teachers' responses should be also taken into consideration to modify the framework. In the research, taking the cultural differences between Germany and China as well as characteristics of Mr. Hua's responses into consideration, I revised the framework of teachers' responses to errors that was designed by Tulis (2013).

Secondly, I concluded the characteristics of Mr. Hua's responses to students' errors as follows: a) Mr. Hua had more adaptive responses (84.7%) than maladaptive responses (15.3%). b) The categories of teachers' responses to errors of Mr. Hua were diverse. c) Almost all categories of adaptive responses but [9] *Waiting* occurred during the interaction between Mr. Hua and his students. d) No maladaptive responses happened except [5] *Correction by the teacher*. Meanwhile, the proportion of [5] *Correction by the teacher* (15.3%) was considerably high. By comparing with findings in prior literature, the research results were in line with this in that Chinese teachers tended to make full use of errors as educational resources to develop students' mathematical thinking. However, it was different from the claim that mathematics teachers had more maladaptive responses by Tulis (2013).

Thirdly, I supposed that the reasons why Mr. Hua responded to students' errors in such ways might be affected by the guidance of the curriculum reform in China, his educational belief (e.g. transforming error strategy) and expertise, and characteristics of public demonstration classes in China. As mentioned before, mathematical classes of Mr. Hua represent the error-tolerated culture which has been promoted by the official guidance of curriculum reform in China. Meanwhile, similar practice addressing making use of errors as teaching and learning resources are common and have also been adopted by many teachers in daily classrooms in China. Therefore, to some extent, the educational practice of Mr. Hua also reflects how mathematics teachers responded to students' errors in China.

Implications and limitations

Some implications can be drawn from this research. Firstly, the process of teacher-student interactions is complicated and can be affected by various factors, so it is necessary to analyse teachers' responses in a realistic and specific situation. Secondly, more research needs to be conducted in different countries especially in developing countries to gain more insight into teachers' responses to errors.

Meanwhile, there were some limitations of this research. First of all, it was a case study and was based on the analysis of four classes of a Chinese teacher, which means the external validity of the research is limited and would affect the generalization of the findings in different backgrounds. Secondly, as the videos were downloaded from the website, I could only get a limited view of interactions between the teacher and students, and I had difficulties in examining specific reasons and related beliefs concerning such behavior. In this case, interviews with the teacher and students would be very helpful in investigating the attitudes and beliefs of them, which can compensate the limitations of video-based observation.

Acknowledgements

This study was based on my Master's dissertation which was submitted to UCL in 2021. Many thanks to my supervisor Dr. Pete Wright for his great support and guidance.

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